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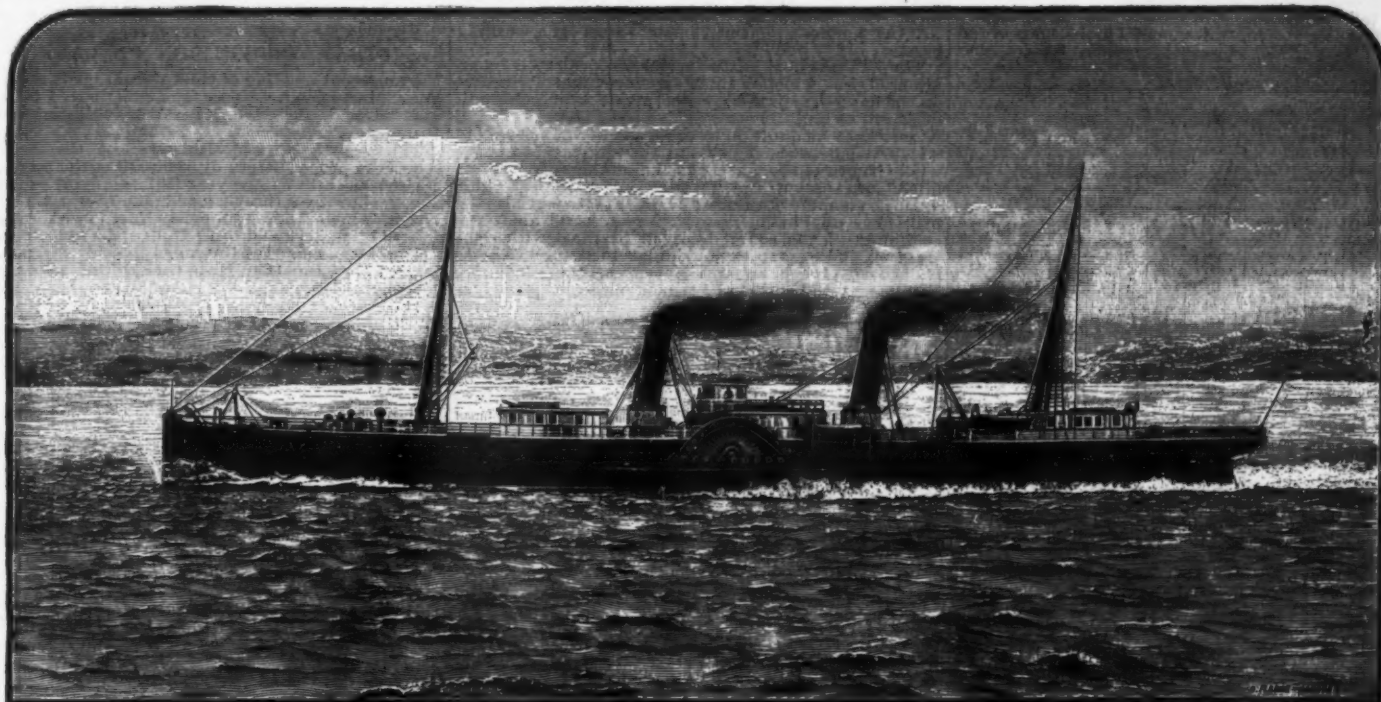
HIGH SPEED PADDLE STEAMERS.

High speed paddle steamers have been produced in considerable numbers by Clyde builders during the past two years, and at the present time many important short sea and river passenger routes around the British coast are thereby benefiting from such enhanced

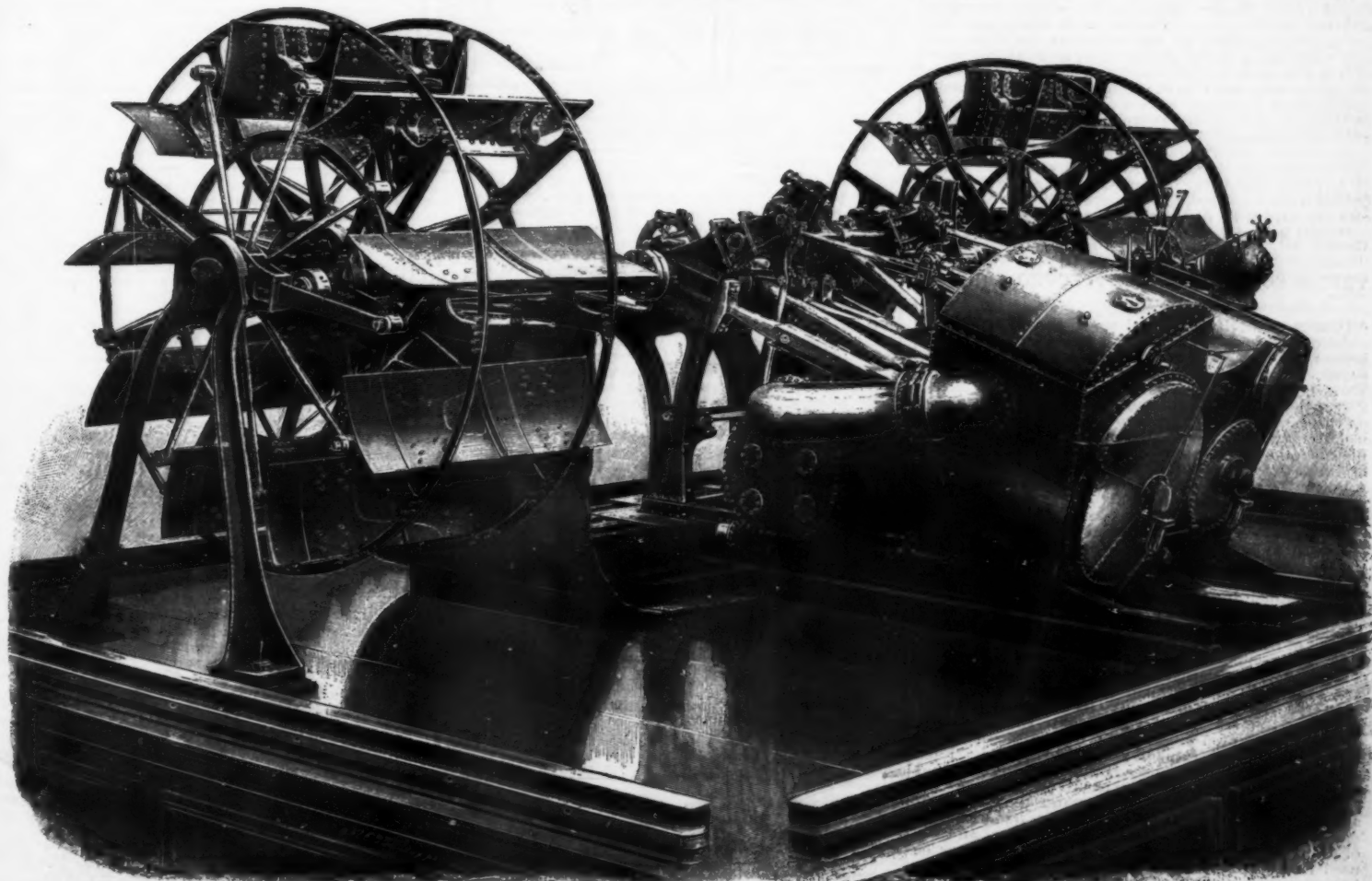
steamboat services. Thus, on the river Clyde, and between Scotland and Ireland, as many as six new steamers have been put on service this year, having average speeds ranging from $16\frac{1}{2}$ to $20\frac{1}{2}$ knots, while similarly swift vessels have been produced for other places.

One of the firms taking a leading part in turning

out this class of work on the Clyde is Messrs. Wm. Denny & Brothers, Dumbarton. This firm, as is now well known, has placed itself in a position for special work and guaranteeing certain results by the speed and resistance experiments they are enabled to carry out in the experimental tank which forms an important appliance in their works. Within the past two



THE PADDLE STEAMSHIP PRINCESS VICTORIA.



PADDLE ENGINES OF THE S.S. PRINCESS VICTORIA.

years they have produced five high speed paddle steamers, all of them doing notable work on their respective services. Two of these are the Belgian-owned Channel boats *Princess Henriette* and *Princess Josephine*, employed on the mail and passenger service between Dover and Ostend, and the third, is the *Duchess of Hamilton*, running between Ardrossan and the Island of Arran, in connection with the train service to Ardrossan of the Caledonian Railway Company, who own the vessel. In a recent issue—June 20—we gave an illustration of this steamer, representing her at her working draught and in motion. The other two vessels in question are the *Princess Victoria*, engaged in Channel service between Stranraer and Larne, and the *Clacton Belle*, now employed on the Thames service between London and Clacton-on-Sea.

Herewith we are enabled to give a view of the *Princess Victoria*, reproduced from a photograph taken while the vessel was in motion; also an illustration representing the type of engines with which all of the boats have been fitted. This is a reproduction from a photograph of a large scale and remarkably complete working model of the engines, shown in the present Edinburgh exhibition. The model is really an exact *fac simile* of the engines fitted into the Dover and Ostend boats, but in every respect, save size of parts, it is also illustrative of the engines supplied to the *Princess Victoria* and the other vessels.

The following table will show, even more clearly than word description, the principal dimensions of the boats; also particulars as to engines, boilers, and speed performances:

	<i>Princess Henriette and Princess Josephine</i>	<i>Princess Victoria</i>	<i>Duchess of Hamilton</i>	<i>Clacton Belle</i>
Ship:				
Length....	300 ft.	280 ft.	250 ft.	240 ft.
Breadth....	30 ft.	25 ft. 6 in.	30 ft.	25 ft. 6 in.
Depth....	13 ft. 6 in.	14 ft.	10 ft. 6 in.	10 ft.
Engines:				
Type....	Two crank compound diagonal.	Two crank compound diagonal.	Two crank compound diagonal.	Two crank compound diagonal.
Dia. of cyls.	30 in. & 104 in.	31 in. & 90 in.	34 in. & 60 in.	38 in. & 50 in.
Stroke....	6 ft.	5 ft. 6 in.	5 ft.	5 ft.
Boilers:				
Type....	Admiralty.	Return tube.	Admiralty.	Admiralty.
Number....	817.	115 lb.	115 lb.	115 lb.
Pressure....	150 lb.			
Trial:				
When....	June 7, 1888.	April 19, 1890.	May 28, 1890.	May 2, 1890.
Where....	Cloch and Cumbræ.	Cloch and Cumbræ.	Cloch and Cumbræ.	Measured mile.
Runs....	Four.	Two.	Two.	Two.
Speed, mean.	21.28 knots.	19.77 knots.	19.00 knots.	17.07 knots.

It is worthy of note that the breadths of most of these vessels bear an unusually large proportion to the length, especially if the width across the paddle wings be taken. This characteristic, while not so detrimental to speed results as designers have hitherto been prone to believe, is certainly somewhat inimical to the best speeds attainable. On the other hand, it has, of course, compensating advantages, such as steadiness of motion, ample deck space, and luxuriousness of appointment generally, all of which, nowadays, seem to be as essential items of real progress in steam navigation as speed and safety. At all events, the elements of comfort and luxury have been well met in these vessels, the fittings, including the electric lighting, having been carefully designed and carried out in their entirety by Messrs. Denny's own employees.

The engines are of a compound diagonal type, designed by Mr. Walter Brock, of the engineering firm of Denny & Company. The valves, it will be noticed, are placed diagonally on the cylinders, the high pressure valve being of the piston type, and the low pressure of the ordinary slide pattern. Steel and brass are extensively used in the construction of the main engines and adjuncts, with a view to weight-saving. In the case of each of the vessels, forced draught is used on the closed stokehold system, Brotherhood's fans being employed. The condenser shell is of plate steel, and the circulating water is supplied by Gwynne's and by Drysdale's centrifugal circulating pumps. Feed for boilers is obtained by Weir's pumps. All the vessels are also provided with distillers for providing fresh water for boiler feed and other purposes.—*The Engineer*.

TRIPLE SCREW STEEL PROTECTED CRUISER No. 12.

UNDER authority conferred upon the navy department by the act of June 30, 1890, plans for a protected cruiser of about 7,300 tons displacement are being prepared. The cut, for which we are indebted to the *New York Sun*, shows the character of the vessel.

The department plans call for a vessel 400 feet long on the mean load line; beam moulded, 58 feet; draught mean normal, 23 feet; extreme normal, 24 feet; displacement normal, about 7,300 tons; speed sustained, 21 knots; and indicated horse power, 30,500. The main battery consists of four 6 inch B. L. R. of high power; eight 4 inch B. L. R., rapid firing; about eighteen machine guns, and six torpedo tubes.

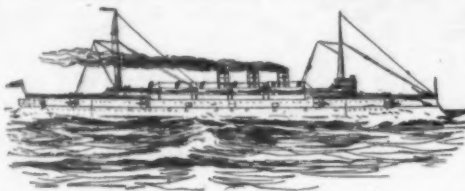
The vessel will have three screws, one placed amidships, as in ordinary single screw vessels, and two others placed further forward, one on each side, as is usual in twin screw vessels. This arrangement has been adopted by the French for some of their later vessels. The machinery and boilers were designed by Engineer-in-chief George W. Melville, U. S. N., and consist of three sets of triple expansion vertical inverted cylinder engines, the center screw being about 4 feet 6 inches below the other two. Each engine is placed in a watertight compartment, and is complete in every respect, so that the vessel may be propelled at a slow speed by the center screw alone; by the two outer screws at a medium speed; and by the three screws when the highest rate of speed is required. Each shaft is fitted with a disengaging coupling, so that when not in use the propellers are free to revolve.

The great advantage of this arrangement is that it allows the machinery to be worked at its maximum and most economical number of revolutions at all rates of the vessel's speed; and each engine can always be used for propelling the vessel, an advantage of great importance, and one that the arrangement of two sets of engines working on the same screw does not possess.

The steam pressure is 160 pounds. Diameter of high

pressure cylinder, 42 inches; of intermediate pressure cylinder, 59 inches; of low pressure cylinder, 92 inches; stroke (common), 42 inches. Steel has been used wherever possible, so as to make the machinery as light as is consistent with safety.

The total I. H. P. at 120 revolutions per minute and a forced draught of one inch of water is 21,000 horses. There are eight main double ended boilers, placed in



THE PROTECTED AMERICAN CRUISER.

four watertight compartments, and two single ended auxiliary boilers placed on the berth deck. The airtight fire room system of forced draught is used.

Total grate surface for the main boilers, 1,321 sq. ft.; heating surface, 41,334.4 sq. ft.; total grate surface for auxiliary boilers, 64 sq. ft.; heating surface, 1,937 sq. ft. All the boilers are constructed of steel for a working pressure of 160 pounds.

The vital portions of the vessel are protected by an armored deck 4 inches thick on slopes and 2½ inches on the flat; the space between this deck and the gun deck will be minutely subdivided by coal bunkers and storerooms; in addition to these a coffer dam 5 feet in width will be worked next to the ship's side for the whole length of the vessel; in the bunkers this will be filled with patent fuel, forming a wall 5 feet thick against machine gun fire; the contents can also be utilized as fuel in emergency; forward and abaft the coal bunkers, the coffer dam will be filled with some water-excluding substance similar to "woodite." In wake of the 4 inch and machine guns, the ship's side will be armored with 4 and 2 inch plates.

The 6 inch guns are mounted in the open, protected by heavy shields attached to the gun carriages.

The accommodations for officers and crew are spacious, well ventilated and lighted. All the most approved modern appliances for exhausting vitiated air, and for incandescent lighting by electricity, have been incorporated in the design.

The coal capacity is very large, reaching 2,000 tons; at 10 knots speed per hour this will give the vessel an endurance of 100 days or a radius of action of 26,240 knots, or in other words she will be able to steam around the world in 100 days without recaling. In appearance the vessel resembles closely an ordinary merchantman, the sides being nearly clear of projections or spousons which ordinarily appear on vessels of war; she will have two signal masts—will have no military tops on them, however. The function of the vessel is to destroy the commerce of an enemy, therefore her general appearance is such as to enable her to get within range before her character is discovered.

As a whole, this vessel will represent the latest idea of a powerful, economical protected commerce destroyer. The hull will be of steel; the vitals of the ship and its stability well protected, and the gun stations shielded against machine guns.

The subdivision of the hull is such as to form a double hull below the water, and offers as great security against damage from torpedo attack as can be given in a vessel of this class.

STEAM PROPULSION ON CANALS.

At a recent meeting of the International Canal Congress, Manchester, a paper was contributed by Alderman W. H. Bailey (Salford), entitled "Notes on Canal Propulsion."

This is partly an historical essay on the earlier attempts to propel barges by means of steam power, and started as early as the year 1737; a quaint wood cut, Fig. 2, showing a three-masted man-of-war towed by a barge, which itself is propelled by a large stern wheel moved by pulleys and ropes from some invisible motor driven by steam. It is intended to show the patented invention of Jonathan Hull, though the motor, an atmospheric steam engine, is stated to have been invented

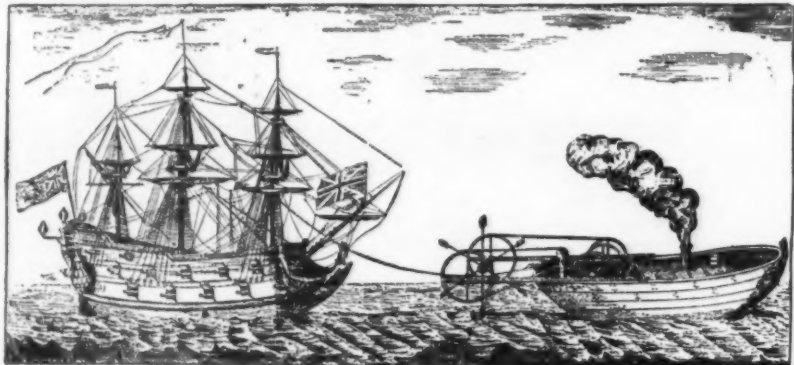


Fig. 2.

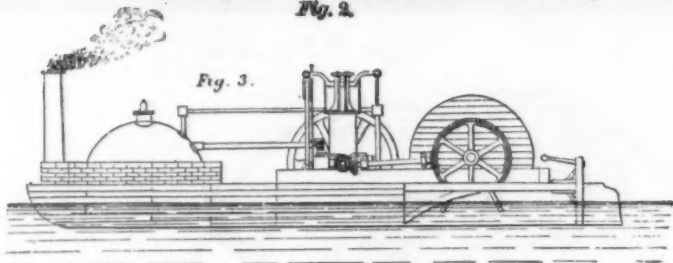


Fig. 3.

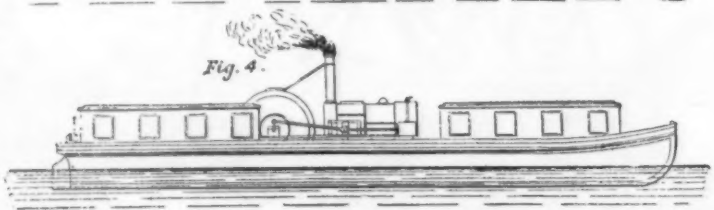


Fig. 4.

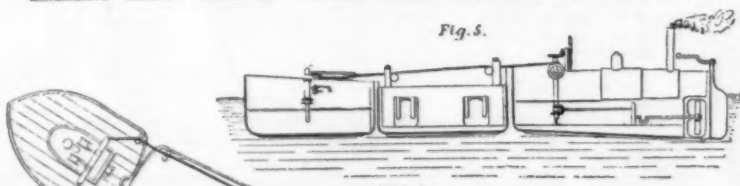


Fig. 5.

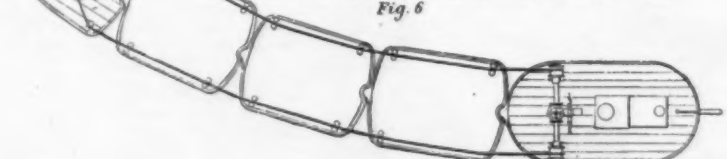


Fig. 6.



Fig. 7.

THE DEVELOPMENT OF STEAM PROPULSION ON CANALS.

by Newcomen. Hull's tug boat does not appear to have done any practical work.

The second illustration, Fig. 3, deals with a paddle wheel boat called Bonaparte, constructed by Fulton, the American inventor, for the Duke of Bridgewater in 1799. It was used upon the Bridgewater canal, but the rate of propulsion seems to have been slower than that by horses, and the canal banks suffered seriously from the wash caused by it. The engines were presently taken out and used for pumping water at a breakdown at Stretford, and thus repaid all outlay for steamboat experiments.

The third illustration, Fig. 4, shows Fairbairn's center paddle wheel boat constructed in 1831 for the Forth and Clyde canal.

Figs. 5 and 6 refer to the boat trains on the Aire and Calder navigation. It is not essential, nor even usual, to have the train of compartments pushed by the steam barge, as shown in the sketch, which is certainly very liable to produce mishaps and damage both to banks and to the train itself, but it is more frequently towed.

The cost of haulage by this system at a speed of from 4½ to 6 miles per hour is said to be 1-34th of a penny for ordinary merchandise, and only 1-119th of a penny for minerals. This system cannot, however, be employed upon canals of small dimensions or with ordinary locks, as it would not do to disconnect the compartments very frequently.

A canal barge of modern construction for carrying cargo is shown in Fig. 7. It was constructed by Mr. W. Wilkinson, of Wigan, for the Leeds and Liverpool canal. The circumstances are somewhat peculiar, as the canal is both shallow and narrow, and there are not less than ninety-three locks, the delay in passing through a train of barges being most serious.

Under these conditions it was advisable to allow each steam barge to carry what may be termed a paying cargo, and to limit the number of barges towed by it to one or two. At this rate a speed of about two miles per hour can be obtained, and in places where the canal is both deeper and wider, 2½ to 3½ miles. The distance traveled averages 40 miles in twenty-four hours, passage of locks included. Weight carried by the steamer is 35 tons, by two barges 80 tons—total 115 tons. Average cost about 1-6th of a penny per ton per mile. It is stated that if 1d. per ton per mile is charged it will, on a run of 100 miles, result in a clear profit of £30 on this cargo.—*Engineering.*

THE PHOTOGRAPHIC IMAGE.*

THE history of a discovery which has been developed to such a remarkable degree of perfection as photography has naturally been a fruitful source of discussion among those who interest themselves in tracing the progress of science. It is only my presence in this lecture theater, in which the first public discourse on photography was given by Thomas Wedgwood at the beginning of the century, that justifies my treading once again a path which has already been so thoroughly well beaten. If any further justification for trespassing upon the ground of the historian is needed, it will be found in the circumstance that in the autumn of last year there was held a celebration of what was generally regarded as the jubilee of the discovery. This celebration was considered by many to have reference to the public disclosure of the daguerreotype process, made through the mouth of Arago to the French Academy of Sciences on August 10, 1839. There is no doubt that the introduction of this process marked a distinct epoch in the history of the art, and gave a great impetus to its subsequent development. But, while giving full recognition to the value of the discovery of Daguerre, we must not allow the work of his predecessors and contemporaries in the same field to sink into oblivion. After the lapse of a half century we are in a better position to consider fairly the influence of the work of different investigators upon modern photographic processes.

I have not the least desire on the present occasion to raise the ghosts of dead controversies. In fact, the history of the discovery of photography is one of those subjects which can be dealt with in various ways, according to the meaning assigned to the term. There is ample scope for the display of what Mr. Herbert Spencer calls the "bias of patriotism." If the word "photography" be interpreted literally as writing or inscribing by light without any reference to the subsequent permanence of the inscription, then the person who first intentionally caused a design to be imprinted by light upon a photo-sensitive compound must be regarded as the first photographer. According to Dr. Eder, of Vienna, we must place this experiment to the credit of Johann Heinrich Schulze, the son of a German tailor, who was born in the Duchy of Magdeburg, in Prussia, in 1687, and who died in 1744, after a life of extraordinary activity as a linguist, theologian, physician, and philosopher. In the year 1737, when experimenting on the subject of phosphorescence, Schulze observed that by pouring nitric acid, in which some silver had previously been dissolved, on to chalk, the undissolved earthy residue had acquired the property of darkening on exposure to light. This effect was shown to be due to light, and not to heat. By pasting words cut out in paper on the side of the bottle containing his precipitate, Schulze obtained copies of the letters on the silvered chalk. The German philosopher certainly produced what might be called a temporary photograph.

Whatever value is attached to this observation in the development of modern photography, it must be conceded that a considerable advance was made by spreading the sensitive compound over a surface instead of using it in mass. It is hardly necessary to remind you here such an advance was made by Wedgwood and Davy in 1802.† The impressions produced by these last experimenters were unfortunately of no more permanence than those obtained by Schulze three-quarters of a century before them.

It will perhaps be safer for the historian of this art to restrict the term photograph to such impressions as are possessed of permanence: I do not, of course, mean absolute permanence, but ordinary durability in the

common sense acceptance of the term. From this point of view the first real photographs, *i. e.*, permanent impressions of the camera picture, were obtained on bitumen films by Joseph Nicéphore Niepce, of Chalons-sur-Saône, who, after about twenty years' work at the subject, had perfected his discovery by 1826. Then came the days of silver salts again, when Daguerre, who commenced work in 1824, entered into a partnership with Niepce in 1829, which was brought to a termination by the death of the latter in 1833. The partnership was renewed between Daguerre and Niepce de St. Victor, nephew of the elder Niepce. The method of fixing the camera picture on a film of silver iodide on a silvered copper plate—the process justly associated with the name of Daguerre—was ripe for disclosure by 1839, and was actually made known in 1839.

The impartial historian of photography who examines critically into the evidence will find that quite independently of the French pioneers, experiments on the use of silver salts had been going on in this country, and photographs, in the true sense, had been produced almost simultaneously with the announcement of the daguerreotype process by two Englishmen whose names are as household words in the ranks of science. I refer to William Henry Fox Talbot and Sir John Herschel. Fox Talbot commenced experimenting with silver salts on paper in 1834, and the following year he succeeded in imprinting the camera picture on paper coated with the chloride. In January, 1839, some of his "photogenic drawings"—the first "silver prints" ever obtained—were exhibited in this Institution by Michael Faraday. In the same month he communicated his first paper on a photographic process to the Royal Society, and in the following month he read a second paper before the same society, giving the method of preparing the sensitive paper and of fixing the prints. The outcome of this work was the "calotype" or talbotype process, which was sufficiently perfected for portraiture by 1840, and which was fully described in a paper communicated to the Royal Society in 1841. The following year Fox Talbot received the Rumford medal for his "discoveries and improvements in photography."*

Herschel's process consisted in coating a glass plate with silver chloride by subsidence. The details of the method, from Herschel's own notes, have been published by his son, Prof. Alexander Herschel.† By this means the old forty-foot reflecting telescope at Slough was photographed in 1839. By the kindness of Prof. Herschel, and with the sanction of the Science and Art Department, Herschel's original photographs have been sent here for your inspection. The process of coating a plate by allowing a precipitate to settle on it in a uniform film is, however, impracticable, and was not further developed by its illustrious discoverer. We must credit him, however, as being the first to use glass as a substratum. Herschel further discovered the important fact that while the chloride was very insensitive alone, its sensitiveness was greatly increased by washing it with a solution of silver nitrate. It is to Herschel, also, that we are indebted for the use of sodium thiosulphate as a fixing agent, as well as for many other discoveries in connection with photography, which are common matters of history.

Admitting the impracticability of the method of subsidence for producing a sensitive film, it is interesting to trace the subsequent development of the processes inaugurated about the year 1839. The first of photographic methods—the bitumen process of Niepce—survives at the present time, and is the basis of some of the most important of modern photo-mechanical printing processes. [Specimens illustrating photo-etching from Messrs. Waterlow & Sons exhibited.] The daguerreotype process is now obsolete. As it left the hands of its inventor it was unsuited for portraiture, on account of the long exposure required. It is evident, moreover, that a picture on an opaque metallic plate is incapable of reproduction by printing through, so that in this respect the talbotype possessed distinct advantages. This is one of the most important points in Fox Talbot's contributions to photography. He was the first to produce a transparent paper negative from which any number of positives could be obtained by printing through. The silver print of modern times is the lineal descendant of the talbotype print. After forty years' use of glass as a substratum, we are going back to Fox Talbot's plan, and using thin, flexible films—not exactly of paper, but of an allied substance, celluloid. [Specimens of talbotypes, lent by Mr. Crookes, exhibited, with celluloid negatives by the Eastman company.]

If I interpret this fragment of history correctly, the founders of modern photography are the three men whose labors have been briefly sketched. The jubilee of last autumn marked a culminating point in the work of Niepce and Daguerre, and of Fox Talbot. The names of these three pioneers must go down to posterity as coequal in the annals of scientific discovery. [Portraits by Mr. H. M. Elder shown.] The lecture theater of the Royal Institution offers such tempting opportunities to the chronicler of the history of this wonderful art that I must close this treatment of the subject by reminding myself that in selecting the present topic I had in view a statement of the case of modern photography from its scientific side only. There is hardly any invention associated with the present century which has rendered more splendid services in every department of science. The physicist and chemist, the astronomer and geographer, the physiologist, pathologist, and anthropologist will all bear witness to the value of photography.

The very first scientific application of Wedgwood's process was made here by the illustrious Thos. Young, when he impressed Newton's rings on paper moistened with silver nitrate, as described in his Bakerian lecture to the Royal Society on November 24, 1803. Prof. Dewar has just placed in my hands the identical slide, with the Newton rings still visible, which he believes Young to have used in this classic experiment. [Shown.]

Our modern photographic processes depend upon chemical changes wrought by light on films of certain sensitive compounds. Bitumen under this influence becomes insoluble in hydrocarbon oils, as in the heliographic process of the elder Niepce. Gelatine mixed with potassium dichromate becomes insoluble in water

on exposure to light, a property utilized in the photo-etching process introduced in 1852 by Fox Talbot, some of whose original etchings have been placed at my disposal by Mr. Crookes. [Shown.] Chromatized gelatine now plays a most important part in the autotype and many photo-mechanical processes. The salts of iron in the ferric condition undergo reduction to the ferrous state under the influence of light in contact with oxidizable organic compounds. The use of these iron salts is another of Sir John Herschel's contributions to photography (1842), the modern "blue print" and the beautiful platinotype being dependent on the photo-reducibility of these compounds. [Cyanotype print developed with ferri-cyanide.]

Of all the substances known to chemistry at the present time, the salts of silver are by far the most important in photography on account of the extraordinary degree of sensitiveness to which they can be raised. The photographic image with which it is my privilege to deal on this occasion is that invisible impression produced by the action of light on a film of a silver haloid. Many methods of producing such films have been in practical use since the foundation of the art in 1839. All these depend on the double decomposition between a soluble chloride, bromide or iodide, and silver nitrate, resulting in the formation of the silver haloid in a vehicle of some kind, such as albumen (Niepce de St. Victor, 1848) or collodion on glass, as made practicable by Scott Archer in 1851. For twenty years this collodion process was in universal use; its history and details of manipulation, its development into a dry plate process by Colonel Russell in 1861, and into an emulsion process by Bolton and Sayce in 1864, are facts familiar to every one.

The photographic film of the present time is a gelatino-haloid (generally bromide) emulsion. If a solution of silver nitrate is added to a solution of potassium bromide and the mixture well shaken, the silver bromide coagulates and rapidly subsides to the bottom of the liquid as a dense curly precipitate. [Shown.] If instead of water we use a viscous medium, such as a gelatine solution, the bromide does not settle down, but forms an emulsion, which becomes quite homogeneous on agitation. [Shown.] This operation, omitting all details of ripening, washing, etc., as well known to practical photographers, is the basis of all the recent photographic methods of obtaining negatives in the camera. The use of this invaluable vehicle, gelatine, was practically introduced by R. L. Maddox in 1871, previous experiments in the same direction having been made by Gaudin (1853-61). Such a gelatino-bromide emulsion can be spread uniformly over any substratum—glass, paper, gelatine, or celluloid—and when dry gives a highly sensitive film.

The fundamental problem which fifty years' experience with silver haloid films has left in the hands of chemists is that of the nature of the chemical change which occurs when a ray of light falls on such a silver salt. Long before the days of photography—far back in the sixteenth century—Fabricius, the alchemist, noticed that native horn silver became colored when brought from the mine and exposed. The fact presented itself to Robert Boyle in the seventeenth century, and to Becarius, of Turin, in the eighteenth century. The change of color undergone by the chloride was first shown to be associated with chemical decomposition in 1777 by Scheele, who proved that chlorine was given off when this salt darkened under water. I can show you this in a form which admits of its being seen by all. [Potassium iodide and starch paper were placed in a glass cell with silver chloride, and the arrangement exposed to the electric light till the paper had become blue.] The gas which is given off under these circumstances is either the free halogen or an oxide or acid halogen, according to the quantity of moisture present and the intensity of the light. I have found that the bromide affects the iodide and starch paper in the same way, but silver iodide does not give off any gas which colors the test paper. All the silver haloids become colored on exposure to light, the change being most marked in the chloride, less in the bromide, and least of all in the iodide. The latter must be associated with some halogen absorbent to render the change visible. [Strips of paper coated with the pure haloids, the lower halves brushed over with silver nitrate solution, were exposed.] The different degrees of coloration in the three cases must not be considered as a measure of the relative sensitiveness. It simply means that the products of photo-chemical change in the three haloids are inherently possessed of different depths of color.

From the fact that halogen in some form is given off, it follows that we are concerned with photochemical decomposition, and not with a physical change only. All the evidence is in favor of this view. Halogen absorbents, such as silver nitrate on the lower halves of the papers in the last experiment, organic matter, such as the gelatine in an emulsion, and reducing agents generally, all accelerate the change of color. Oxidizing and halogenizing agents, such as mercuric chloride, potassium dichromate, etc., all retard the color change. [Silver chloride paper, painted with stripes of solutions of sodium sulphate, mercuric chloride, and potassium dichromate, was exposed.] It is impossible to account for the action of these chemical agents except on the view of chemical decomposition. The ray of light falling upon a silver haloid must be regarded as doing chemical work; the vibratory energy is partly spent in doing the work of chemical separation, and the light passes through a film of such haloid partly robbed of its power of doing similar work upon a second film. It is difficult to demonstrate this satisfactorily in the lecture room, on account of the opacity of the silver haloids, but the work of Sir John Herschel, J. W. Draper, and others has put it beyond doubt that there is a relationship of this kind between absorption and decomposition. It is well known also that the more refrangible rays are the most active in promoting the decomposition in the case of the silver haloids. This was first proved for the chloride by Scheele, and is now known to be true for the other haloids. It would be presumption on my part in the presence of Captain Abney to enlarge upon the effects of the different spectral colors on these haloids, as this is a subject upon which he can speak with the authority of an investigator. It only remains to add that the old idea of a special "actinic" force at the more refrangible end of the spectrum has long been abandoned. It is only because the silver haloids absorb these particular rays that the blue end of the spectrum is most active in pro-

* Friday evening lecture delivered at the Royal Institution by Prof. Raphael Meldola, F.R.S., on May 18, 1890.—*Nature.*

† "An Account of a Method of Copying Paintings upon Glass, and of making Profiles by the Agency of Light upon Nitrate of Silver. Invented by T. Wedgwood, Esq. With Observations by H. Davy." *Journ. R. I.* 1802, p. 170.

* For these and other details relating to Fox Talbot's work necessarily excluded for want of time, I am indebted to his son, Mr. C. H. Talbot, of Lacock Abbey.

† *Photog. Journ. and Trans. Photog. Soc.*, June 15, 1872.

moting their decomposition. Many other instances of photo-chemical decomposition are known in which the less refrangible rays are the most active, and it is possible to modify the silver haloids themselves so as to make them sensitive for the red end of the spectrum.

The chemical nature of the colored products of photo-chemical decomposition is still enshrouded in mystery. Beyond the fact that they contain less halogen than the normal salt, we are not much in advance of the knowledge bequeathed to us by Scheele in the last century. The problem has been attacked by chemists again and again, but its solution presents extraordinary difficulties. These products are never formed—even under the most favorable conditions of division and with prolonged periods of exposure—in quantities beyond what the chemist would call "a mere trace." Their existence appears to be determined by the great excess of unaltered haloid with which they are combined. Were I to give free rein to the imagination, I might set up the hypothesis that the element silver is really a compound body invariably containing a minute percentage of some other element, which resembles the compound which we now call silver in all its chemical reactions, but alone is sensitive to light. I offer this suggestion for the consideration of the speculative chemist.* For the colored product as a whole, *i. e.*, the product of photo-decomposition with its combined unchanged haloid, Carey Lea has proposed the convenient term "photosalt." It will avoid circumlocution if we adopt this name. The photosalts have been thought at various times to contain metallic silver, allotropic silver, a sub-haloid, such as argentous chloride, etc., or an oxyhaloid. The free metal theory is disposed of by the fact that silver chloride darkens under nitric acid of sufficient strength to dissolve the metal freely. The acid certainly retards the formation of the photosalt, but does not prevent it altogether. When once formed the photochloride is but slowly attacked by boiling dilute nitric acid, and from the dry photosalt mercury extracts no silver. The assumption of the existence of an allotropic form of silver insoluble in nitric acid cannot be seriously maintained. The sub-haloid theory of the product may be true, but it has not yet been established with that precision which the chemist has a right to demand. We must have analyses giving not only the percentage of halogen, but also the percentage of silver, in order that it may be ascertained whether the photosalt contains anything besides metal and halogen. The same may be said of the oxyhaloid theory: it may be true, but it has not been demonstrated.

The oxyhaloid theory was first suggested by Robert Hunt† for the chloride; it was taken up by Sahler, and has recently been revived by Dr. W. R. Hodgkinson. It has been thought that this theory is disposed of by the fact that the chloride darkens under liquids, such as hydrocarbons, which are free from oxygen. I have been repeating some of these experiments with various liquids, using every possible precaution to exclude oxygen and moisture; dry silver chloride heated to incipient fusion has been sealed up in tubes in dry benzene, petroleum, and carbon tetrachloride, and exposed since March. [Tubes shown.] In all cases the chloride has darkened. The salt darkens, moreover, in a Crookesian vacuum.‡ By these experiments the oxychloride theory may be ecotched, but it is not yet killed; the question now presents itself whether the composition of the photosalt may not vary according to the medium in which it is generated. Analogy sanctions the supposition that when the haloid darkens under water or other oxygen-containing liquid, or even in contact with moist or dry air, an oxychloride may be formed, and enter into the composition of the photosalt. The analogy is supplied by the corresponding salt of copper, viz., cuprous chloride, which darkens rapidly on exposure. [Design printed on flat cell filled with cuprous chloride by exposure to electric light.] Wohler conjectured that the darkened product was an oxychloride, and this view receives a certain amount of indirect support from these tubes [shown], in which dry cuprous chloride has been sealed up in benzene and carbon tetrachloride since March; and although exposed in a southern window during the whole of that time, the salt is as white as when first prepared. Some cuprous chloride sealed up in water, and exposed for the same time, is now almost black. [Shown.]

When silver is precipitated by reduction in a finely divided state in the presence of the haloid, and the product treated with acids, the excess of silver is removed and colored products are left which are somewhat analogous to the photosalts proper. These colored haloids are also termed by Carey Lea photosalts, because they present many analogies with the colored products of photo-chemical change. Whether they are identical in composition it is not yet possible to decide, as we have no complete analyses. The first observations in this direction were published more than thirty years ago in a report by a British Association committee,§ in which the red and chocolate colored chlorides are distinctly described. Carey Lea has since contributed largely to our knowledge of these colored haloids, and has at least made it appear highly probable that they are related to the products formed by the

action of light. [Red photochloride and purple photo-bromide and iodide shown.]

The photographic image is impressed on a modern film in an inappreciable fraction of a second, whereas the photosalt requires an appreciable time for its production. The image is invisible simply because of the extremely minute quantity of haloid decomposed. In the present state of knowledge it cannot be asserted that the material composing this image is identical in composition with the photosalt, for we know the composition of neither the one nor the other. But they are analogous in so far as they are both the result of photo-chemical decomposition, and there is great probability that they are closely related, if not identical, chemically. It may turn out that there are various kinds of invisible images, according to the vehicle or halogen absorbent—in other words, according to the sensitizer with which the silver haloid is associated. The invisible image is revealed by the action of the developer, into the function of which I do not propose to enter. It will suffice to say that the final result of the developing solution is to magnify the deposit of photosalt by accumulating metallic silver thereon by accretion or reduction. Owing to the circumstance that the image is impressed with such remarkable rapidity, and that it is invisible when formed, it has been maintained, and is still held by many, that the first action of light on the film is molecular or physical, and not chemical. The arguments in favor of the chemical theory appear to me to be tolerably conclusive, and I will venture to submit a few of them.

The action of reagents upon the photographic film is quite similar to the action of the same reagents upon the silver haloids when exposed to the point of visible coloration. Reducing agents and halogen absorbents increase the sensitiveness of the film; oxidizing and halogenizing agents destroy its sensitiveness. It is difficult to see on the physical theory why it should not be possible to impress an image on a film say of pure silver bromide as readily as on a film of the same haloid embedded in gelatine. Every one knows that this cannot be done. I have myself been surprised at the extreme insensitiveness of films of pure bromide prepared by exposing films of silver deposited on glass to the action of bromine vapor. On the chemical theory we know that gelatine is a splendid sensitizer, *i. e.*, bromine absorbent. There is another proof which has been in our hands for nearly thirty years, but I do not think it has been viewed in this light before. It has been shown by Carey Lea, Eder, and especially by Abney—who has investigated the matter most thoroughly—that a shearing stress applied mechanically to a sensitive film leaves an impression which can be developed in just the same way as though it had been produced by the action of light. [Pressure marks on Eastman bromide paper developed by ferrous oxalate.] Now that the result cannot be produced on a surface of the pure haloid, some halogen absorbent, such as gelatine, must be associated with the haloid. We are concerned here with a chemical change of that class so ably investigated by Prof. Spring, of Liege, who has shown that by mere mechanical pressure it is possible to bring about chemical reaction between mixtures of finely divided solids.* Then again, mild reducing agents, too feeble to reduce the silver haloids directly to the metallic state, such as alkaline hypophosphites, glucose or lactose and alkali, etc., form invisible images which can be developed in precisely the same way as the photographic image. All this looks like chemical change, and not physical modification pure and simple.

I have in this discourse stoically resisted the tempting opportunities for pictorial display which the subject affords. My aim has been to summarize the position in which we find ourselves with respect to the invisible image after fifty years' practice of the art. This image is, I venture to think, the property of the chemist, and by him must the scientific foundation of photography be laid. We may not be able to give the formula of the photosalt, but if the solution of the problem has hitherto eluded our grasp, it is because of the intrinsic difficulties of the investigation. The photographic image brings us face to face, not with an ordinary, but with an extraordinary class of chemical changes, entirely due to the peculiar character of the silver salts. The material composing the image is not of that definite nature with which modern chemical methods are in the habit of dealing. The stability of the photosalt is determined by some kind of combination between the sub-haloid or oxyhaloid, or whatever it may be, and the excess of unaltered haloid which enters into its composition. The formation of the colored product presents certain analogies with the formation of a saturated solution; the product of photo-chemical decomposition is formed under the influence of light up to a certain percentage of the whole photosalt, beyond which it cannot be increased—in other words, the silver haloid is saturated by a very minute percentage of its own product of photo-decomposition. The photosalt belongs to a domain of chemistry—a no-man's land—peopled by so-called "molecular compounds," into which the pure chemist ventures but timidly. But these compounds are more and more urging their claims for consideration, and sooner or later they will have to be reckoned with, even if they lack that definiteness which the modern chemist regards as the essential criterion of chemical individuality. The investigation may lead to the recognition of a new order of chemical attraction, or of the old chemical attraction in a different degree. The chemist who discourses here upon this subject at the end of the half century of photography into which we have now entered will no doubt know more about this aspect of chemical affinity; and if I may invoke the spirit of prophecy in concluding, I should say that a study of the photographic film with its invisible image will have contributed materially to its advancement.—*Nature*.

TESTS of aluminium bronze have been commenced at the Watertown Arsenal, Massachusetts, under the auspices of the Government. The tensile strength was shown to be something over 90,000 lb. to the square inch, and the transverse strength 66,000 lb. on a 1 in. square bar.

* The connection between the two phenomena was suggested during a course of lectures delivered by me two years ago ("Chemistry of Photography," p. 191). I have since learned that the same conclusion had been arrived at independently by Mr. C. H. Botnamley, of the Yorkshire College, Leeds.

PERFUME MAKING IN NICE.

THE method of making perfumes in Nice is described as follows by the British consul in that town: The first process in the manufacture of perfume from flowers and herbs is the extraction of the essential oil by distillation. A large copper vessel or alembic is filled with water to about two-thirds of its capacity; the flowers to be treated are then introduced, and it is hermetically [sic] closed. It is placed on a fire, gas or steam being mostly used for this purpose in Nice. Steam is thus generated in the cylinder, and is carried by means of a pipe into a second cylinder, which is constantly kept replenished with cold water, and is furnished with an overflow cock. The pipe, in its passage through this second cylinder, assumes the form of a coil. This coil ends in a cock at the bottom of the cylinder, from which the volatile essence exudes drop by drop as the steam becomes condensed in its passage through the coil.

In this manner the essence is collected in a small glass vessel, while at the same time the water containing a small portion of the scent, and which still remains in the alembic aforesaid, is itself perfumed, and becomes the rose water or orange flower water of trade.

All flowers are not susceptible of this treatment—some of them, such as jessamine, violet, cassia, and tuberose, have to be treated by a different process.

Of the flowers producing essences, the orange flower yields 1 gramme of essence for one kilo of flowers. This oil is styled "neroli," and is the principal essence produced in the district between the Var and the Italian frontier. The following table shows the proportionate yield of the different flowers:

Neroli.....	1,000 kilos. of flowers	1 kilo. of essence.
Rose.....	25,000 " "	" 1 " "
Geranium..	1,000 " "	" 1 " "
Mint.....	1,000 " "	" 0.750 " "
Orange leaf (bitter)...	1,000 " "	" 1 " "
Lavender...	100 " "	" 0.500 " "
Eucalyptus.	100 " "	" 0.500 " "

There are two processes used for the purpose of ex-

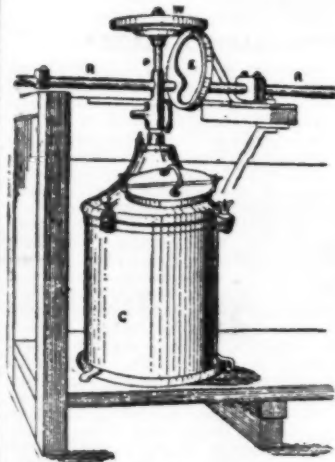


FIG. 1.



FIG. 2.

tracting perfume from flowers which do not contain volatile essence.

The first may be described as the cold process and the second as the hot process.

The former is generally used for cassia (*Acacia Farnesiana*), jessamine, jonquils, tuberose, violets, and some other flowers.

Freshly gathered flowers are placed upon a layer of pure lard, a quarter of an inch in thickness, spread over a sheet of glass about two feet square, which is framed in wood and forms a tray. These trays, sometimes some 40 or 50 together, are then piled upon one another; the flowers are changed every 12, 18, or 24 hours, according to circumstances, and the process is thus continued until the lard is sufficiently charged with perfume. Jessamine and tuberose are frequently changed as often as 50 times before the lard is considered to be sufficiently impregnated, cassia and violets from 30 to 40 times, and jonquils about 20 times only. In the hot process 20 kilos. of grease are placed in a copper vessel, together with some 5 kilos. of flowers; the vessel is then placed over a slow fire, and the contents are well stirred. After allowing the compounds to boil for ten minutes, the vessel is left to cool for some hours; an additional 5 kilos. of flowers are then added, and the process is repeated until the fat has absorbed the requisite amount of perfume; the hot liquid is then poured through a sieve, and the greasy flower paste that remains is subjected to hydraulic pressure. It is in these two ways that the "pommades" of trade are produced.

The machinery used in the production of "extraits" from the pommades is very simple, and the only apparatus calling for special notice is the "battuse a extraits," by which the perfume is conveyed from the impregnated fat into the alcohol, and which is shown in our illustration.

The fat is inserted in cylinder, C, together with a certain amount of alcohol; there are usually four churns side by side attached to the same connecting rod, R, which ends in a wheel connected with the steam engine by means of the usual band; the rod being thus set in rapid motion, the eccentric, E, lifts, depresses, and rotates the wheel, W, which sets the piston, P, rotating, and alternately raising and falling at the same time. Fig. 2 shows the portion of the piston rod which is contained in the cylinder, and to which horizontal flanges are attached, and it will be readily seen that the churning process obtained by their rotating at the same time that they rise and fall through the mass of fat and alcohol is of a most efficient nature.

* I have gone so far as to test this idea experimentally in a preliminary way, the result being, as might have been anticipated, negative. Silver chloride, well darkened by long exposure, was attracted with a hot saturated solution of potassium chloride, and the dissolved portion, after precipitation by water, compared with the ordinary chloride by exposure to light. Not the slightest difference was observable either in the rate of coloration or in the colors of the products. Perhaps it may be thought worth while to repeat the experiment, using a method analogous to the "method of fractionation" of Crookes.

† "Researches on Light," second ed., 1854, p. 80.

‡ Some dry silver chloride which Mr. Crookes has been good enough to send up for me in a high vacuum darkens on exposure quite as rapidly as the dry salt in air. It soon regains its original color when kept in the dark. It behaves, in fact, just as the chloride is known to behave when sealed up in chlorine, although its color is, of course, much more intense after exposure than in the case with the chloride in chlorine.

§ These results were arrived at in three ways. In one case hydrogen was passed through silver citrate suspended in hot water, and the product extracted with citric acid. "The result of treating the residue with chlorohydric acid, and then dissolving the silver by dilute nitric acid, was a rose-tinted chloride of silver." In another experiment the dry citrate was heated in a stream of hydrogen at 212° F., and the product, which was partly soluble in water, gave a brown residue, which furnished "a very pale red body on being transformed by chlorohydric and nitric acids." In another experiment silver arsenite was formed, this being treated with caustic soda, and the black precipitate then treated successively with chlorohydric and nitric acids: "Silver is dissolved, and there is left a substance . . . [of] a rich chocolate or maroon," etc. This, on analysis, was found to contain 24 per cent. of chlorine, the normal chloride requiring 24.74 and the sub chloride 14.06 per cent. The committee which conducted these experiments consisted of Messrs. Maskelyne, Hadow, Hardwick, and Liewellyn. B. A. Rep., 1869, p. 108.

EGROT'S TILTING STILL.

As well known, when alcoholic liquors are distilled, the ordinary still furnishes at the first operation a liquid that has to be distilled a second time in order to obtain common spirits.

In order to simplify these operations, Mr. Egrot, about two years ago, devised a new type of still that permits of obtaining rectified spirits at the first operation. This apparatus is held in some favor, and so we think it of interest to make its principle known. It consists essentially of a still in which the liquids to be distilled are placed, and communicating with the refrigerator through an inclined pipe. The still, A (Fig. 1), is placed in a furnace, B, of which the part, C, is so arranged that the still can be tilted in front. It suffices for this to maneuver the lever seen to the left of the engraving, when the toothed wheel, D, will revolve upon E, and the still will take the position shown in Fig. 3.

The cover, G, of the still is provided with a screw

in a very fine shower. The impure vapors that condense in the worm, L, return to the still. Nothing but the alcohol vapors pass into the worm, M. Here they condense, are cooled in the refrigerator, N, and are collected upon their exit. During this entire operation the cock, R, must remain closed.

If it is desired to distill very rapidly, without endeavoring to produce rectified spirits, the cock, S, is kept closed, and the cock, R, is opened. As the worm, L, is no longer cooled, the aqueous vapors will not condense therein, and will go directly to the worm, M, where they alone will condense.

It will be readily understood that the degree and quality of the spirits can be thus regulated at will by increasing or diminishing the opening of the cock.

The principal advantages of this apparatus are as follows:

1. One man can tilt the still and empty it, without any trouble. As the still is cleaned in this position, the operation is easily effected. The still resumes its position without having to be remounted and luted.

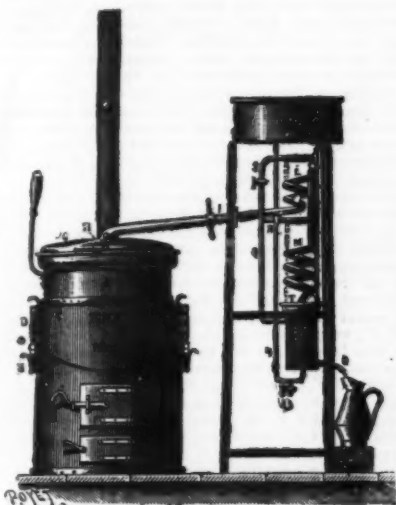


Fig. 1.



Fig. 2.

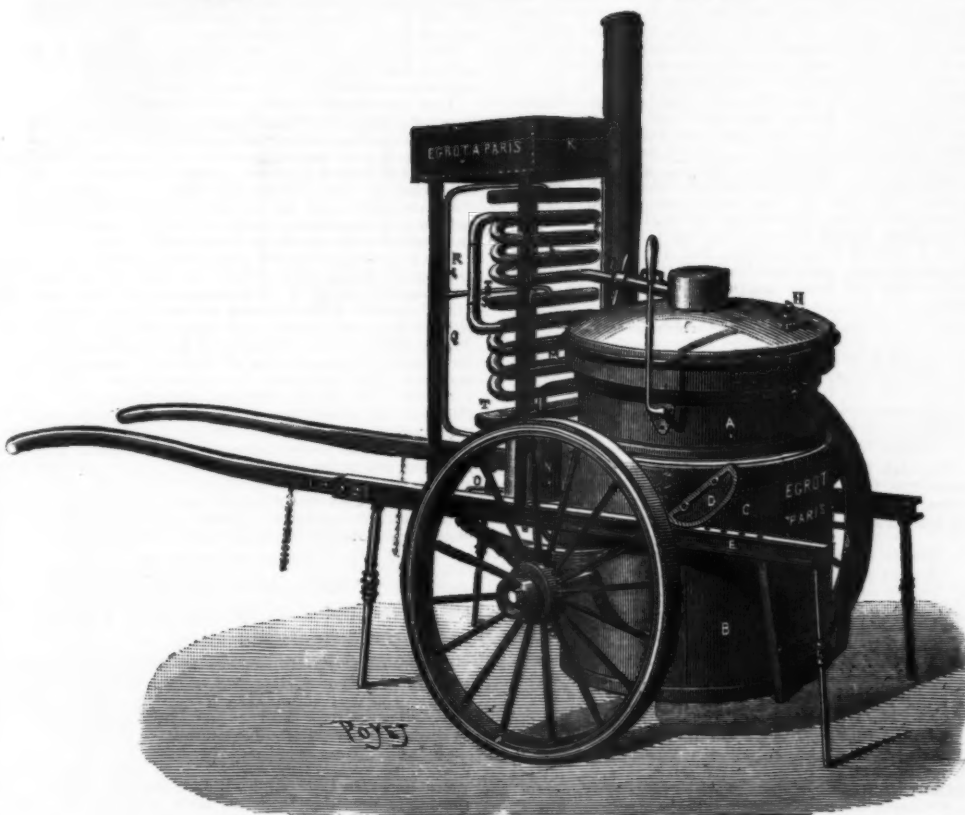


Fig. 3.

EGROT'S TILTING STILL.

plug, H, for the filling, and a swan's neck connected with the refrigerator by a screw coupling. The refrigerator consists of two copper worms, L and M, upon which water falls in a shower. The poor vapors that condense in the worm, L, return to the still. As for the vapors rich in alcohol, they pass through the worm, M, into the refrigerator, N, and make their exit at O, in the state of alcohol.

Water from a reservoir, K, descends through the tube, P, into the refrigerator, N, and then ascends through the tube, Q, above the worm, L, and falls in a shower upon both worms. This water is collected in a reservoir, T. The discharge of the water is regulated by the cocks, R and S.

The operation of the apparatus is very simple. The materials to be distilled are introduced into the still, A. The cover is put on, and the coupling screwed up. The cocks, R and S, having been closed, the reservoir, K, is filled with water, and a fire is lighted in the furnace.

After ebullition has started in the still and the worm, L, has begun to heat, the cock, S, is opened slightly, so that the water may spread over the worms

2. With this apparatus spirits of 50 and 60 degrees or more can be obtained at will at the first operation and without faints.

3. The refrigerator consumes less than half the water required by that of any other still known.

The capacities of these stills range from 6 to 200 gallons.

Mr. Egrot has arranged a still of this type upon wheels (Fig. 3). This may be easily wheeled about by a man, and used by landowners who have to distill upon estates distant from each other. As may be seen in the figure, the wheels are very large, and the axle well above ground, thus rendering the vehicle easy rolling, and permitting it to pass over the worst roads. Moreover, the frame and wheels are of iron, thus preventing the inconveniences that might arise from the presence of wood near the furnace. The prop rods are provided with a mechanism that permits of elongating or shortening them at will, thus simplifying the putting of the apparatus in place.

Finally, let us have something to say about a still provided with a wine heater (Fig. 4), and which has

the advantage over the one just described of permitting of effecting several distillations much more rapidly and economically by making use of the vapors to heat the liquid designed for the next operation.

Its operation is sensibly the same as that of the ordinary tilting still.

While the still, A, is being charged with the materials to be distilled, material is likewise introduced into the heater, V, through the tubulure, U, until the liquid is observed to flow through the gauge cock, Z, which is not closed until this moment.

After the apparatus is in operation, the alcoholic vapors traverse the heater, through a worm, and



Fig. 4.

heat the contained liquid, which, toward the end of the operation, reaches a temperature near that of ebullition.

In order to begin a second operation, it suffices to adapt to the cock, X, a rubber tube, and to allow the hot liquid to pass through it into the still. The heater is afterward filled with liquid for the next operation.—*Annales Industrielles.*

AN IMPROVED SURVEYOR'S INSTRUMENT.

THE accompanying illustration represents a readily applied improvement in the stands of theodolites and field transits, whereby the telescope can easily have its height adjusted after the instrument has been leveled. The invention forms the subject of a patent issued to Mr. John R. Hanlon, of Pennington, N. J. A boss depending from the limb or upper plate is recessed to receive the tapering upper end of the spindle, as shown in the sectional view. A cylindrical sleeve fits on the spindle below the boss, and turns thereon, a clamping collar surrounding the sleeve at its lower end, and a clamping screw engaging this collar by means of lugs or ears to bind the sleeve when necessary and prevent its turning on the spindle. A spring catch is also fastened securely to the clamp, and fits into a groove running completely around the inner sleeve, to prevent the possibility of the transit accidentally slipping from the spindle. The outer surface of the sleeve above the clamp is screw-threaded to engage the similarly threaded interior surface of an outer cylindrical sleeve,



HANLON'S SURVEYOR'S INSTRUMENT.

the upper end of which screws upon the boss depending from the upper plate. This outer sleeve has longitudinal slits extending upward from its lower end, surrounded by a clamping collar with clamping screw. When the bottom clamp is loosened the instrument can be turned laterally to any desired angle, and when the upper clamp is loosened the outer sleeve may be screwed up to any desired height on the inner sleeve. By this means the telescope has its height accurately adjusted after being leveled. It is not necessary that the spindle extend up into the boss, as the attachment can be made without altering the original spin-

die, the inventor having added the attachment to his own transit, and describing the work of the instrument therewith as very accurate and complete.

A FOOT POWER BLOWPIPE.

TINNERS very often use the blowpipe in doing small soldering jobs, etc., and some experience great difficulty in holding their work, or in keeping the blowpipe steady and in the right portion of the flame to produce good work. I did, and therefore hope my method may be of use to some who read this.

I first made some bellows. Figs. 1, 2, and 4 will explain how I made them. Take two pieces of wood $\frac{1}{2}$ inch thick, each eight by ten inches. In top one bore two holes, one at A, one inch in diameter, and one at B $\frac{1}{4}$ inch in diameter. At B glue a circular tapering block of wood with a $\frac{1}{2}$ inch hole through the center. Into this hole drive firmly a small piece of brass tube, the inside measure of which should be $\frac{1}{4}$ inch. On the other side of the board, at A, Fig. 1, fix the clapper to the bellows, D, Fig. 2, which is a piece of thin wood about two inches square with a piece of soft leather glued on the side next the board. Another piece of leather, C, serves as a hinge, and a string, E, fastened one end to the clapper and the other on the board, serves to keep the clapper from dropping down too far.

Should any tinner not understand the making of bellows, it is perhaps necessary to say that there must be a little drop on the clapper, as it is desirable to have it shut immediately after the pressure is put on. Two spiral springs are then fastened at G, to keep the bellows always open. A strip of leather is nailed across the ends of the two boards at F for a hinge, and another piece of leather shaped like Fig. 4 tacked around the edges, closing everything in. The tacks

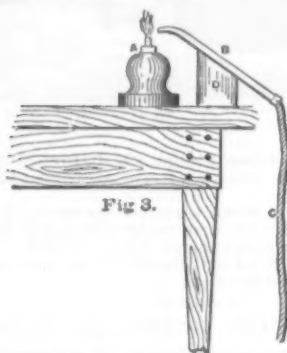


Fig. 1.

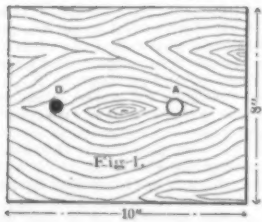


Fig. 2.

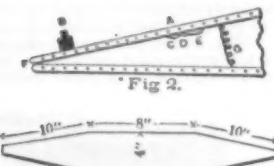


Fig. 3.

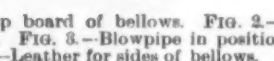


Fig. 4.

FIG. 1.—Top board of bellows. FIG. 2.—Section of bellows. FIG. 3.—Blowpipe in position for work. FIG. 4.—Leather for sides of bellows.

should be driven close together and the leather drawn tight.

Sheepskin is a good leather to use, or if the tinner cannot spend the time to make them, he can of course use an ordinary pair. Now, on the bench where you work is fastened a piece of wood shaped like D, Fig. 3. The shape of this block depends on the style of blowpipe you use, and any tinner will at once see what he needs.

The blowpipe, B, is then fastened on the incline or slant by two wire staples, and is connected with the outlet of the bellows at B, Fig. 3, by a small rubber tube, when it is complete. If the bellows are made light and the clapper adjusted properly, a fierce heat can be kept up. Once you get this fixed up you would not be without it on any account. It is always ready for use and comes in handy for all sorts of odd jobs.—H. J. W., American Artisan.

HEAT MEASURING.*

In the course of actual manufacturing, heat measuring is even more important than in the laboratory, but, unfortunately, the instruments at our disposal for the measurement of temperature do not help us much beyond a certain figure. The main difficulty in the construction of high temperature heat-measuring apparatus is the selection of material of which the apparatus can be made. When we remember that platinum melts below 1,800° C., cast iron below 1,100° C., lime glass at about 1,900° C., and many varieties of fire clay at 2,000° C., the difficulties of construction will become apparent.

The following temperatures of known physical crises are generally accepted as being fairly accurate, those with an asterisk (*) may be depended upon for accuracy, and those marked (†) to within a few degrees; so that a range of temperature from the melting of ice to

that of platinum can be fairly well established. There may be gaps difficult to fill, but the existence of well defined stepping stones will, no doubt, be of great service, and help to fix in the minds of chemical engineers the effect of temperature which might otherwise be neglected.

Substances.	State.	Deg. C.	Deg. F.
*Ice.....	Melts at	0	32
*Water.....	Bolls "	100	212
*Tin.....	Melts "	235	455
*Lead.....	" "	326	617
*Mercury.....	Bolls "	360	680
*Zinc.....	Melts "	410	770
*Sulphur.....	Bolls "	448	838
*Aluminum.....	Melts "	635	1,187
*Gold.....	" "	1,063	2,012
*Steel.....	Fuses "	1,300	2,372
*Palladium.....	" "	1,500	2,732
*Platinum.....	" "	1,800	3,272
Firebrick.....	Fuses about	2,000	3,632

Gold, silver, and copper are generally rated to fuse at about 1,000° C. to 1,950° C. (about 2,000° F.), and cast iron at 1,275° C. (about 2,300° F.), and platinum fusing at 1,800° C. melts when thrown on to the surface of molten glass.

Some scientists attach great importance to the exact determination of temperature in manufacturing processes. There is no doubt that in many operations where reactions take place in specified and very narrow limits, the exact determination of the degree of heat employed is a very important matter, and we should in all cases endeavor to arrive at as near the truth as possible; but unless there is a definite and valuable point in making determinations of such great accuracy, it is as well not to overlook the fact that the game may not be worth the candle.

The most common method of ascertaining temperature is by the unaided eye; we speak of the heat as dull red, cherry red, orange, white, and by it we mean, no doubt, to be definite in our description, and certainly workmen who are trained to observe temperature color can observe very well. Still, the untrained eye may be very seriously in error. For my own part, I have had experience in three processes requiring careful regulation of heat, the Hargreaves salt cake process, the Deacon chlorine process, and the carbonizing of coal, and therefore can speak with authority upon the subject. I have found that a good, steady foreman, when in perfect health, may train his eye to keep very steady heats by means of his eye alone, but the state of a man's health does materially affect his color perception, and, moreover, heat determinations conducted by this method should only be made when the eyes are completely shaded from extraneous light. It is difficult to say what is the lowest degree of heat that can be seen, perhaps 400° F. has been observed, but dull red is generally taken to mean 500° C.; cherry red 800° C.; orange red 1,000° C.; white heat 1,300° C.; while the dazzling white heat of the glass furnace cannot be less than 1,500° C. to 1,900° C. For temperatures above 1,000° C. the color is oftentimes observed through a piece of cobalt blue glass, which softens the light by absorbing the yellow part of the spectrum, but the use of this medium requires considerable practice. The following table may put these temperatures in a more graphic form:

TEMPERATURES.	Deg. C.
Black heat.....	400
Dull red heat.....	500
Cherry red heat.....	800
Orange red heat.....	1,000
White heat.....	1,300
Dazzling white heat.....	1,500

Pouillet has stated that a thin plate of platinum takes the following colors at the indicated temperatures. His own terms are given so that there may be no mistake as to the meaning:

	Deg. C.
Rouge foncé dans l'obscurité.....	525
Rouge sombre.....	700
Cerise naissant.....	800
Cerise clair.....	1,000
Orange foncé.....	1,100
Orange clair.....	1,300
Blanc.....	1,800
Blanc soudant.....	1,400
Blanc éblouissant.....	1,500 to 1,600

As I have already shown, the mercury thermometer may be employed for all temperatures, say up to 340° C., or say 640° F., up to which I have frequently gone in testing chimney gases, with average accuracy when using Phillips' maximum registering thermometer. An instrument for measuring temperatures from 300° C. to 1,000° C. is still much required, or even to 1,500° C., but as steel melts at 1,300° C. I fear that platinum is the only suitable metal, and therefore not available, except for determinations of more than ordinary importance.

Pyrometers are much used for temperatures varying from 300° C. to 600° C., but I have not found one single make yet that would work continuously and give satisfaction, but I have on many occasions known that the fireman has found the pyrometer out of order, by comparison with the temperature color. I am speaking now of pyrometers working on the principle of the differential expansion of two dissimilar substances; there may be others more reliable, but, anyhow, they are not in general use.

Pyrometers, to be of any material service, should not only be able to indicate the actual temperature at the time, but to detect variations in the temperature, so as to give ample warning to the fireman before actual damage is done. The material in manufacturing operations often takes a long time in heating up, and when a critical point is reached, it will probably take as long or longer to cool down, the cooling being very uncertain when some chemical change is taking place in which heat is evolved. There are however two forms of pyrometer that deserve careful trial. Murrie's is one form, the other is Schaffer and Budenberg's thal-potassium. In Murrie's pyrometers the action of the instrument can readily be understood

by comparison with an ordinary mercurial barometer. In the barometer the pressure only of the atmosphere is taken into account, no allowance being made for variations in the temperature of the atmosphere. As mercury volatilizes in a vacuum, it is evident that under certain conditions the tension of the mercurial vapor in the space intermediate to the upper surface of the column of mercury and the sealed end of the tube, known as the vacuum space, may be sufficient to affect the height of the column of mercury to a greater or less extent. For instance, assuming the tube to be enveloped by air heated to nearly 680° F.—the boiling point of mercury under the normal atmospheric pressure—the tension of the vapor will balance the pressure of the atmosphere, and in consequence the column of mercury in the barometer tube will be depressed to the same or nearly the same level as that of the mercury in the receiver. Moreover, any decrease in the temperature of the surrounding atmosphere will cause the vapor of mercury to partially liquefy and the column of mercury to ascend. Supposing that instead of the lower end of the tube to be open to the atmosphere, the tube is sealed by a sensitive pressure gauge, and the tube heated as before, the mercury could not then descend, but the tension of the vapor would be transmitted through the intermediate column of mercury to the pressure indicator, and any variation in the tension of the vapor due to heating or cooling of the mercury at the point of contact with the vapor would at once be shown on the indicator, which could be graduated to show the corresponding temperature. On this basis about sixty forms of instruments are constructed, embracing nearly all ranges of temperature met with in practice.

These instruments are reported to be in use in many chemical establishments, but I have not been able to secure any reliable reports regarding them. Some of the purposes for which they are specially constructed may perhaps be mentioned here. From 0° F. to 50° F. for use in refrigerators, cooling chambers, etc.; to temperatures up to 300° F., with a range of 100° F. for heated water or steam; for temperatures from 300° F. to 1,000° F., with a range of 300° to 600° on each dial. A series has been made for tar distillers, stearine stills, and oil stills, ranging on each dial from 300° to 600° F.; 350° to 800°; 350° to 900°; and 400° to 1,000° F. For hot air blast, superheated steam, a set has been devised ranging from 400° F. to 2,000° F. The price of these instruments varies from three to six guineas each.

Two special instruments are constructed to guide the attendant in the heating and cooling of caustic soda, viz., an instrument ranging from 1,000° F. to 1,400° F., to show the temperature of the material as it is being heated, and also to show when sufficient heat has been applied, and a second instrument ranging from 400° F. to 800° F., to show when the material has sufficiently cooled down to be removed from the pots.

The construction of the thal-potassium is based on the well known fact that the pressure of a saturated vapor corresponds to its temperature.

The instrument consists of a metal tube (brass or iron) of sufficient strength, partly filled with a suitable liquid (ether, water, or mercury), which is exposed to the influence of the temperature to be ascertained, and connected with a pressure gauge, by means of which the pressure imparted to the vapor is indicated. The dials are graduated by actual experiment, the temperature corresponding to the different pressures being calculated on the basis of Regnault's tables.

For low temperatures the tube is generally of brass and partly filled with ether, the dial being graduated from 100° to 220° F., for temperatures varying from 212° F. to 680° F. the liquid is water and the tube of iron or brass, while for heats above 680° F. to say 1,500° F. the tube is iron or steel and the liquid mercury. I have used these pyrometers for several years, and, if carefully fixed and used, they are reliable; after a time however, the fluid escapes somewhat or becomes changed in character, and the instrument must be overhauled and adjusted. All high temperature pyrometers must be protected against oxidation. For this purpose an outer iron protecting tube is requisite, which should be partly filled with lead. The lead forms a bath, excludes the air and so prevents the oxidation of the pyrometer tube. The price of each of these thal-potassiums is about five guineas.

COLOR AND COLORING.*

By Prof. A. H. CHURCH, M.A., F.R.S.

LECTURE II.

Complementary Colors.—The chromatic circle, to which I drew your attention in last Monday's lecture, is also, you will have seen, a contrast circle. On its circumference may be arranged a host of colors, limited in number only by the discriminative power of the human eye. These colors will be united in pairs by the diameters connecting them. Each color has its complementary in that color which is 180° off, that is, most remote in position from its own place on the circle; the pair united in equivalents from white. In other than equivalents one hue preponderates, but a tint is thus formed, for it is merely the uncombined excess which is perceived mingled with the white produced by the equivalents. Conventionally, we speak of white as present in the center of the circle. In truth, it is present at different points on each of all possible diameters, in accordance with the value of each chromatic equivalent. And when we concern ourselves with pigments, we shall soon discover that their positions are variously disturbed by their divergence from normal standards of hue, purity, and brightness.

Besides the numerous complementary pairs which we can place and recognize on the circle, there are many corresponding pairs *within* its area situated on its diameters. These are complementary *tints*. And outside the circle, on the prolonged diameters, will be found complementary *shades*—that is, colors of reduced brightness.

There are several ways of learning the complementary of any hue. In practice we generally desire to ascertain the complementary hues of colored materials. To this question we confine ourselves now. As such materials produce their hue by selective absorption, we cannot expect to obtain white from the union of the rays they send to the eye, but must be content with a

* Abstract from a course of lectures delivered by Mr. George E. Davis, at the Manchester Technical School.

* Recent lectures before the Society of Arts, London. From the Journal of the Society.

neutral gray, often with a very dull or dark gray. One method of ascertaining the complementary of say a pigment consists in erecting a sheet of glass in such a way that we can see directly through it the pigment of which we want to ascertain the complementary hue. We then cause an image of each of a series of trial complementaries to be seen by reflection on the glass, so that the direct and the reflected images coincide. When the patch of light thus produced has no positive hue in it, we know that our trial complementary color is the true one. But this method is troublesome, so we generally use another, mixing the lights reflected from the pair of colors by rotating colored sectors. The case of brown paper is generally taken in order to illustrate this method. We prepare a disk of such paper, and associate it with such angular amounts of other disks as shall produce on rotation a neutral gray. In this particular instance Rod found that it required 45 parts of artificial ultramarine and 14 parts of emerald green to produce a greenish blue which should neutralize 41 parts of brown pasteboard color. The gray these complementaries yielded was matched by rotating 24 parts of white and 76 of black paper. Just look a little more closely into the chromatic constituents of this pair of complementaries. The three pigments—vermillion, emerald green, and artificial ultramarine—required in order to yield a gray need to be rotated in the proportions 36 : 34 : 30. But the complementary of our pasteboard contained the emerald green and ultramarine in the ratio 14 : 45 or 9 : 30. Consequently the pasteboard must have furnished the equivalent of 24.7 parts of emerald green as well as that of 36 parts of vermillion. But these proportions of emerald green and vermillion, when mixed by rotation, produce an orange yellow of rather low luminosity—a broken tint of orange yellow—and it is by this term that we should define the color of the particular brown pasteboard. [It should be noted here that by the successive impressions of colors on the eye, produced in the rotation experiments, we do not get the added luminosities of the pigments, but only their mean luminosity, and that our bright yellow and orange pigments possess a degree of brightness quite out of proportion to that of most of our pigments of other hues.]

If we put aside the questions of brightness and purity, taking into consideration hue only, we may describe all complementary pairs as made up of—

- (a.) One primary and one secondary, or of
(b.) Two secondaries.

Examples of a are furnished by the pairs:

Red : sea green.
Green : purple.
Blue : yellow.

Among the countless instances of b, I name:

Orange : greenish blue.
Orange yellow : turquoise.
Greenish yellow : violet blue.
Yellowish green : purple violet.
Bluish green : crimson.

There is one characteristic of all true complementary pairs of colors—they do not affect each other's hues. They are already as unlike in hue as possible, and cannot, therefore, mutually modify this color constant. They may, and often do, modify their apparent luminosity and purity. So in the pair "blue : yellow," which affords, next to "black : white," the strongest possible difference of tone, the blue makes the yellow at once brighter and paler, while the yellow makes the blue at once purer and less luminous. The characteristic of the non-alteration of hue when the complementaries are placed in contact affords a criterion of the truly complementary nature of any pair of colors. For instance, in this diagram of true and false complementaries, in the pair "red : green," the red makes the green look bluer than it is, while the green makes the red appear to incline toward purple. So in the pair "yellow : purple," the yellow looks somewhat greenish, the purple somewhat violet, and in the pair "blue : orange," the blue inclines toward green, and the orange toward yellow. These are examples of the peculiar optical effect known as simultaneous contrast, in which two contiguous surfaces which differ in one or more of the constants of color have such differences mutually enhanced or modified. Of such contrasts of hue, brightness and purity, I shall have something further to say directly, but I want to ask you first which of my columns of supposed complementary pairs commends itself to your judgment and taste as preferable? I do not say that the strongest possible contrasts of hue, as afforded by our approximations to the complementaries, are necessarily agreeable, but I do feel that the similar series constructed on the false basis of the red-yellow-blue theory is decidedly unpleasant: the angular intervals between the pairs should have been greater or less. Red with sea green seems to be more agreeable to the eye than red with green. Green with purple looks better than with yellow. Blue with yellow better than blue with orange. That these effects are not wholly due to differences in brightness may be argued from this case of blue with orange, where I have tried to lower the saturation of the orange so as to make it brighter than the blue with which it is associated. But the inherent falsity of the red-yellow-blue theory precludes one from giving to these pairs of complementaries their proper share of brightness—assuming for the moment that we could really accomplish such a result with pigments.

Contrasts of Tone and Hue.—Contrasts are of three kinds, namely, contrasts of hue, contrasts of brightness, contrasts of purity. I have already directed your attention to contrasts of hue. The other two kinds of contrast now demand notice. The best illustration I can give you of contrast of tone will be one in which we shall produce simultaneously a series of grays. By means of this black figure mounted on a white disk we shall produce a series of optical mixtures of black and white, regularly increasing the white by five steps. The outermost ring of gray will be the palest tint of black, the innermost the deepest shade of white. But you will observe another and unexpected appearance produced in this experiment. Each ring seems to be itself united and shaded, although it must really be of one uniform gray. Simultaneous tone contrast is produced, not by optical fatigue, but by an error of judgment. The effect is enhanced by the difference of tone on each side of these contiguous rings, for the middle ring is bounded by a darker shade of gray on one side, and is there made lighter by contrast, while on the

other side it is in contact with a paler tint of gray, and is there made darker by contrast. The immense importance of this phenomenon in pictorial and decorative art is well known. It, of course, takes place with positive colors as well as with negative. If, in an engraving or Indian ink drawing, a certain dark space seems monotonous and heavy, a single touch of a darker shade will at once lighten and vary it, while just in the same way a lighter stroke on a tint which is too pale will enrich and deepen it. In both cases the result of simultaneous contrast will relieve the flatness of the work.

When positive colors come into the arrangement of differing tones, the results may be indicated by means of a few diagrammatic figures. Suppose we begin by introducing a kind of brown in the form of a disk. This color of medium depth is deepened by a smaller half disk of white near its center, and lightened by the contiguity of a corresponding half disk of black. Again, suppose we place a small disk of full blue upon a larger disk half white and half black, the black will make the blue it touches less pure, that is, will lighten it, while the white will affect the blue in an exactly opposite way.

We now proceed a step further, and take two colors instead of one. Using the same reddish brown color as before, we place it on a disk of deep blue, and find that it becomes lighter in tone and less pure, while at the same time it acquires a distinctly yellow cast, having thus received a portion of the complement of blue. Similarly on an orange red (red lead color) disk, lighter in tone than its own, it appears deeper in tone, and assumes a somewhat greenish blue cast, though this effect is but slight, owing to the addition of this complementary mainly serving to neutralize some of the red in the brown disk.

A third case may now be considered. We select for apposition two colors which are separated from one another by a comparatively small angular interval in the chromatic circle, and which are both somewhat bright. We find, as we might expect, that their mutual action as to alteration of tone is but slight, while their change of hue is more decided, each tending to recede farther from its companion by acquiring more of the complementary hue. Here visual fatigue and the warping of the judgment both conduce to the same result.

Harmonies of Color.—I must now ask you to consider what are called chromatic harmonies. Chevreul's classification of harmonies under two headings—harmonies of analogy and harmonies of contrast—is somewhat arbitrary. All harmonies are in varying degrees harmonies of contrast. In every chromatic harmony there is contrast, contrast of hue, or of brightness, or of purity. Contrast generally, therefore, does not afford a criterion of classification. No fundamental difference really exists between those harmonies where change of tone or of hue is gradual and those where it is abrupt; it is a matter of degree, and is quantitative rather than qualitative. I do not see my way to improving the arrangement which I proposed in my "Manual of Color" (pp. 134 to 139). I suggested arranging the various possible harmonies upon the arc of a circle, placing the harmonies of close analogy at one end, the harmonies of strong contrast at the other:

1. The passage, by insensible differences, of the tints, shades, or broken tints of one hue, from light to dark.
2. The gradation, by small but regular, definite, and perceptible steps, of the tints, shades, or broken tints of a single hue, from light to dark.
3. As in 2, but each step separated by a neutral element, as white, gray, or black.
4. The passage, by insensible differences, of one hue, or of its tones, into another related hue or its tones.
5. The gradation by definite steps of one hue, or of its tones, into another related hue or its tones.
6. As in 5, but each step separated by a neutral element.
7. The passage, by insensible differences, of one hue, or its tones, into another chromatically remote hue.
8. The gradation, by definite steps, of one hue into another chromatically remote hue.
9. As in 8, but each step separated by a neutral element.
10. The collocation of different tones.
11. The collocation of chromatically distant hues.
12. The collocation of chromatically distant hues separated by a neutral element.

The idea of seriation or gradation becomes more and more involved with that of decided change as we follow the sequence of these numbers; analogy gives place to contrast.

This classification may be illustrated by a few examples, but I have no time to develop the subject completely. And it must be noted that such definitions as I have offered are of use in the way of suggestion, but must not be allowed to fetter the imagination of the artist; they cannot take the place of experiment, observation, knowledge, and sensitive perception of chromatic beauty.

I take three examples only; they will serve to illustrate Nos. 5, 6, and 7.

The diagram shows the gradation in three steps only of yellow to orange (No. 5 above); and also the same gradation when the neutral elements, white, gray, or black, are inserted (No. 6). These cases furnish examples of the use of what has been variously termed "the dominant hue," and "the small interval." We may illustrate it by the budding foliage of spring, the changing hues of autumn, and the association of nearly related hues in many flowers, as several kinds of daffodil.

My next diagram shows the passage of red to blue (No. 7 above). Really it is only a more extreme case of No. 4, but there is not here a chromatic element common to the whole series of passage hues, for the red at one end contains no blue, and the blue at the other end no red.

Associated Colors.—Of pairs, or dyads, I must say a few words. These are of three orders, namely, complementary pairs, large interval pairs, small interval pairs. Complementary pairs, when their tones differ considerably, as in the case of deep red with bright sea green; or when they contain much white, or are pale; or when they contain much black, or are of low luminosity; or when they are at once of low luminosity and contain white (that is, are broken with gray), are all, or may be, so adjusted as to be agreeable. Large interval pairs are usually more difficult of management, and when both possess a full degree of saturation, are often

unpleasant. Cases are afforded by red with yellow, orange red with blue green, orange with purple, orange yellow with green, orange with green, and greenish yellow with turquoise. The dilution of one of the pairs with a neutral element generally improves these combinations, but some of them, though so strong as to require moderation in use, are naturally excellent. Among these may be named red with blue, orange red with blue, orange yellow with violet, and blue green with violet. In these cases, however, there is normally a considerable difference in the luminosity of the two colors associated in pairs. By beauty of material and of pattern some of the simplest dyads may yield exquisite effects, as in Italian velvets and brocades of the 16th century. Such dyads are yellow green with medium violet, pale olive green with deep indigo, leaf green with deep blue, and pale leaf green with deep amber.

The simplest triads contain two colors and a neutral. Suppose we desire to associate violet and blue, we may interpose with agreeable effect between them white or a pale gray, but not black. The blacks available have a low degree of luminosity, and so do not differ enough from the full blue and full violet we are using; moreover they become tinted with an unpleasant rusty hue, the complementary of the blue or violet. Generally the poor and bad dyads may be improved by the introduction of a third element, while good dyads are often spoiled thereby. Good triads may frequently be secured by taking three hues rather widely separated from each other on the chromatic circle, and, as a general rule, two of these hues should be pale or bright, one deep or dark, or *vice versa*. Except in special circumstances it will be easier to many of these triads when two of the members belong to the "warm" side of the circle and one to the "cold." I give a few good triads:

Amber,	Leaf green,	Leaf green,
Cream,	Puce (deep),	Violet,
Blue (medium)	Rose gray,	Salmon.
Amber,	Terra cotta,	Apricot,
Blue (pale),	Maroon,	Crimson,
Crimson,	Sage green,	Gold brown.
Flesh red,	Maroon,	Red (normal),
Blue (normal),	Bronze yellow,	Gold,
Olive green,	Olive green (dark),	Blue (normal).
Brick red,	Bluish green,	Lavender,
Indigo,	Violet,	Turquoise,
Sea green,	Red ochre,	Blue (deep).

Other examples of triads, and of more complex color combinations, taken chiefly from historic and national chromatic arrangements, are:

1. Blue (deep) or lavender (pale)
2. Gold amber
3. Vermilion red in fine lines on 2 (Ancient Egyptian)
1. Lavender (pale)
2. White
3. Black
4. Red brown (medium)
- on ground of 5, orange yellow
- 6, ochre yellow (Assyrian)
1. Chamols leather
2. Raw sienna
3. Venetian red
- on ground of 4, black (Greek)
1. Blue (medium)
2. White
3. Red
4. Greenish gray
- with outlines of 5, black (Moresque)
1. Silver with outlines of 3, puce, all on ground of 4,
2. Gold pale emerald green (Indian)
1. Silver
2. Lavender
3. Emerald green (medium)
- with 4, white in bands, and 5, black in lines (Irish MS.)
1. Silver area = 0.4
2. Gold area = 0.4
3. Red edgings area = 0.1
4. Black ground area = 0.1 (Irish MS.)
1. Lavender
2. Lemon yellow
3. Crimson (medium)
4. White (in strap work)
5. Green (medium)
- with as lines and ground, 6, black (Irish MS.)
1. Bluish green (full)
2. Yellowish olive (medium)
3. Orange (pale)
4. Blue (full)
5. Purple (medium)
6. Crimson
1. Crimson (medium)
2. Salmon
3. Yellow (pale)
4. Yellow green (medium)
5. Yellowish olive (medium)
6. Maroon

And now I desire to draw your particular attention to one of those characters of good color which is of supreme importance. You will understand the nature of this "quality" in color when I have described and analyzed illustrative examples. I begin by choosing a few cases in which it is either absent or irretrievable. A surface of matt paint of one uniform tone and hue, and illuminated by a direct and colorless light, is confessedly prosaic and uninteresting; so also is a piece of self-colored "surface" paper or a plain printed cotton cloth. All the materials are flat, and they exhibit no variations of tone or hue, or, at least, no perceptible variations. Of all the hues that can be chosen as examples of this point, perhaps the full red, the full green, and the full blue are the most telling; but the full orange and the full violet come very near to them. If the generally accepted theory of the three primary color sensations being red, green, and blue be accepted, we shall, perhaps, be able to suggest a partial explanation of the unpleasant appearance of a considerable surface of any one of the three above named hues when alone in the visual fatigue of one set of optical nerve fibrils which they severally cause. Orange and violet are, however, assumed to affect the red and green fibrils and the red and blue fibrils respectively. Yet, in the case of these two colors (orange and violet), the stimulation of the two sets of fibrils which they each cause is not equal, for the orange has an excess of red in it, and the violet has an excess of blue. If we select other hues in which the two components are present in equivalent if not in equal proportions, the force of our argument is, I think, increased. Such hues are yellow (red + green), sea green (green + blue), and purple (blue + red). Now, it will be generally conceded that the contemplation of an *undiluted* yellow is less displeasing to the eye than that of orange or red, sea green than green or blue, and purple than violet. Such comparisons are, I confess, very difficult to make, and, without special contrivances for excluding all disturbing elements, they are quite inconclusive. With the pigments commonly employed for such comparisons, the varying amount of white light they reflect, and

the presence of chromatic elements other than those we desire to compare, do more than imperil the accuracy of the result. And then the presence of backgrounds and surroundings modified the effects produced. These depend, also, very much upon the manner in which the colored substances used are illuminated. Even with the spectrum colors themselves a just comparison is by no means easy. I am reluctant to illustrate my argument by citing the case of certain sounds, because the analogy between color and sound has been frequently pushed to unwarrantable lengths; yet I think I may say that an absolutely pure note of uniform pitch, without the simultaneous presence of those harmonious constituents which combine to form its timbre, would be no more pleasing to the ear than a pure full color of elementary character is to the eye.

Hitherto I have been speaking of full colors, colors, that is, which are intense and saturated, and also pure or unmixed with white. The current theory of color sensation does, however, assume that there is some stimulation of all the three kinds of optical fibrils caused by each color, however pure. Still the sensation, say, of green is caused by an immensely preponderating stimulation of the green fibrils over that of the blue and red fibrils. A corresponding statement may be made with regard to the sensations of blue and of red. In these instances, the fibrils not necessary to the production of the two sensations in question are even less stimulated than in the case of green, a difference which has been attributed to the median position of the latter hue in the spectrum, and, therefore, to its intermediate wave length. It is argued that the green nerve fibrils which respond to the vibrations of green light are capable of responding, to a slight extent, to the vibrations of light on either side of green, but that the red nerve fibrils are somewhat less affected by the impact of the vibrations at the other end of the spectrum, and *vice versa*. In confirmation of this view I may mention the curious observation that the last color to disappear when a continuous and normal spectrum is gradually reduced in luminosity is the green. That it appears finally as a gray, having but a faint tinge of green, is quite in accordance with theory. And it may not be out of place to observe in this connection that the full, nearly normal green, as represented by the pigment emerald green, is much more luminous than the full red as represented by vermilion, probably in a ratio approaching 2:1.

One reason, then, why pure white and the infinite series of tones of gray do not offend the eye as do certain pure, full, and luminous colors, may be traced to the equal stimulation of the three sets of optical fibrils which they cause. Tints of any color—the full color lightened with white; shades of any color—the full color darkened with black; broken tints of any color—the full color dulled with gray, come into the same category; for the stimulations they cause, though not equable like that of white and of gray, either approach equality, or are less energetic and one-sided than those of the full normal hues.

We are now in a position to offer some explanation, inadequate though it be, of the peculiar satisfaction afforded to the eye by one of the characteristics of beautiful color. We call it "throbbing," "pulsating," "palpitating." This quality may be imparted to it in several ways, by which its dead uniformity is broken, or its *eriant* effect is subdued. The fluctuation in question may be caused by—

Light and shade from inequalities of surface or irregular scattering of light.

Varying surface reflections.

Passage from transparency to opacity.

Varying depth of hue.

Variations of hue limited to the "small interval."

Several of these causes often conspire to produce throbbing color in one and the same case, and they will be best illustrated by a few concrete examples.

The case of rough paper which has received a uniform wash of water color furnishes us with an illustration of the effect of light and shade as modifying hue. We will assume that the pigment has been so equally distributed that the hollows of the surface have not retained more than the elevations. Then we shall find, in the case of many pigments of full color, that the hue in the hollows differs from that in the prominences. For instance, if French ultramarine has been used, the hollows will show a color tending slightly toward violet, while the pigment on the elevations will exhibit a purer blue. In practice, the effect will be augmented by the varying amounts of pigment which have lodged in different parts, the hollows retaining more than the elevations. The same wash of the same pigment on smooth paper will present a different appearance; and in order that the effect of the pigment on the latter may rival that on the rough, it will be necessary to introduce a second pigment, perhaps even a third. That the difference in question is not one of light and shade only may be proved by comparing the two kinds of colored surface in a suitable instrument constructed on the principle of Lovibond's tintometer, and admitting of the examination of small isolated points or patches of color, the chromatic analysis of these points will be found to vary not merely in depth but also in hue.

That the majority of painters in water colors should prefer a comparatively rough paper for their work to the smooth sameness of Bristol board is not surprising. One admits of happy accidents of hue, and even involves them; the other demands the introduction of labored effects, while the result, at the best, is inferior.

Our second cause has been called "varying surface reflections." To illustrate it we will take a piece of porcelain. The glaze may vary in thickness; parts may be more perfect in gloss than other parts; it may even exhibit iridescence. A colorless glaze may produce modifications of the hue of the colors beneath it by reflecting from its surface in varying amounts the colored rays which fall upon it from surrounding objects, or by itself decomposing the white light by which it is seen. In both cases its color will be variously changed, even when that color was originally flat and uniform. I have in my mind, at the moment, a vase of old Chinese egg shell porcelain of an amber yellow. This color is due to lead antimoniate, a substance which has become partially incorporated with the colorless glaze in the kiln. The surface reflection varies in intensity; in some places it reflects the incident white light unchanged, in others it shows iridescent colors, chiefly purple and greenish blue. The fluctuation of color is produced by the mingling of the

light which has passed through the yellow pigmentary layer and has then been reflected to the eye from the white subjacent ground with the light directly reflected from the glossy surface. From different portions of the surface we receive light of at least four different hues, namely, the original yellow; the same color diluted with white; pale orange yellow, where the original yellow hue is modified by commixture with the purple of the iridescence; and pale greenish yellow, where it is similarly mingled with the greenish blue rays from the glaze. Of course in some positions the iridescence alone can be perceived, just as in others the original amber yellow alone is visible.

When a color varies in transparency or opacity, we get a third case of fluctuation. This variation is generally accompanied by variations in depth and hue, but it alone suffices to bring about the quality we are considering. Let us take an illustration from oil painting. We shall require two pigments, one transparent, the other opaque. It will be difficult to match them exactly as to hue, but vermilion and a kind of madder red will answer sufficiently well. We spread a very thin layer of the latter upon a white or colorless ground; some distance off we prepare a similar patch of the vermilion; between the two we make a graduated mixture of the two pigments, and thus obtain the passage of a transparent color into an opaque color; yet the whole colored area is a red, and a red which can be represented by one and the same numerical expression when referred to the wave length of the corresponding hue in the spectrum. But instead of employing these two pigments in the diagrammatic fashion, let us use them in pictorial or decorative painting by placing the two pigments side by side, or glazing with the translucent pigment, or scumbling with the opaque upon the same background. Only in some such way is it possible to suggest the throbbing colors seen in many natural objects, feathers, precious stones, marbles, etc. Of course in representing these we are not restricted to the use of a pair of colors of the same hue and depth; and the limitations we imposed upon ourselves were intended merely to simplify the consideration of this third source of pulsating color. Let me add that the fluctuation here is between two red lights, one of which reaches the eye after passing twice through a translucent red medium, while the other is produced by selective reflection from the surface of an opaque red solid. I say opaque although in point of fact the incident light, or rather a part of it, plunges to some depth among the red particles of vermilion and passes through them, a chromatic selection being thereby made. And it is really in this manner that the light finally reflected to the eye by this pigment, having lost in selective absorption some of its colored constituents, is red. I might cite many examples of the fluctuation of color produced by the passage of an opaque color into a transparent one or by the juxtaposition of two closely related colors, one of which is due to surface reflection, the other to reflection from an appreciable depth: the sea, for instance, when it shows the local blue color of the water itself, and associated with this, the reflected blue of the sky. The effects produced in certain textiles, such as linen and silk, damasks and velvets, partly belong here, but they are also connected with the variations due to inequalities of surface and to differing powers of reflection.

The fourth and fifth causes of the throbbing color are to be traced to variations in depth of one color, or to slight variations in hue; they may be fitly considered together, for in actual examples they are generally associated. Again, we may have recourse to Chinese porcelain for an illustrative example. There is a beautiful ceramic color known as dragon's blood; its hue varies much in different specimens, and even in the same specimen, but the red element always largely preponderates. The red sometimes approaches a red purple, that is, has a small proportion of blue in it; more often it oscillates between a crimson and the color known in France as *garance dorée*. The crimson varies in depth. Sometimes it is a full and saturated color, sometimes it passes into a paler tint, a kind of rich rose pink. The *garance dorée* is a translucent red, which, when diluted, has a somewhat golden red or orange red hue. When we examine a good specimen of this kind of porcelain, we may sometimes detect the presence of all the colors I have named, as well as of their intermediate or passage tints. These hues are separated from one another in the chromatic circle by a small number of degrees; they illustrate the effect of the collocation of colors differing by what is called "the small interval." If the circle be divided into 100°, their extreme range will amount to about 10°. And the most extreme colors are not in juxtaposition, for one slides into another by imperceptible gradations both of tone and of hue. And a range so extensive as 10° is by no means necessary in order that the prosaic flatness of ordinary color may be avoided; possibly a range of 2° or 3° may suffice, even if it be unaccompanied by variation of tone. Colored glass, of good quality, may be chosen as affording an excellent illustration of the points now under consideration, but I reserve it for fuller consideration later on, although I may observe, in passing, that the fluctuations in color of the transparent enamel on porcelain, and of glass, arise from the same causes, only that, as we look at porcelain and through glass, surface iridescence in the latter plays either no part, or a very small part, in the production of the phenomena in question. Of course I exclude from consideration glass intended to be looked at, that is, those vessels of glass, colored or uncolored, which owe their beauty of hue to the iridescence of their surface.

I have now shown, I trust, that throbbing color is produced in more than one way, and that it is agreeable to the eye, even when we are unconscious of the elements that concur in its production, at least in part through physiological causes. I do not think these causes furnish an adequate explanation of the pleasure such color affords, for its charm is doubtless connected with certain fluctuations of our judgment when any element of contrast in color or in tone comes in with the agreeable associations it recalls, and with its complexity and mystery. We do not see it all at once, nor do we instantly grasp its full meaning. Its effect may be likened to that of an intricate architectural vista, or of a range of distant mountains, or of the cadences in the exquisitely chosen language of a beautiful poem. I cannot but think that throbbing color is as necessary to chromatic decoration as to pictorial art.

You are familiar with the numerous and most useful colored designs which illustrate Owen Jones' "Grammar of Ornament." Translate these flat and terribly prosaic figures from the uniformly colored paints with which they have been printed into those precious materials—silk, and marble, and glass—which present delicate variations of tone and of hue, and at once the chromatic combinations are ennobled, changed from awkward prose into refined poetry fraught with varied interest. It is just in the same way that the sympathetic painter of landscape treats the clouds and the sky. He is not satisfied with white and gray for the former, and with blue for the latter. He does not merely graduate his tints, but suffuses his whites and grays with faint suggestions of amber and apricot, and rose; and varies his azure with hints of lavender and of aqua-marine.

A SMALL ELECTRIC MOTOR FOR AMATEURS.

By C. D. PARKHURST.

THE frequent inquiry as to the practicability of small electric motors, the method of making, etc., leads me to believe that such a motor is much to be desired. And as such a motor has been made and has proved a success, I therefore give the drawings and descriptions.

The motor was made to drive a fan for ventilation and a cool breeze in warm weather, and also to see how small a motor could be made that would fill the bill. Doubtless there are many who would like to possess some such affair themselves, and are only kept from making one for want of data as to the size, etc., that can be successfully made.

This little motor is well within the compass of any ordinary lathe with slide rest. So much has been written as to how to make large motors that no particular description need be given for this motor except where its construction differs. Hence the description will be brief.

Fig. 1 shows end elevation of the magnet cores. Fig. 2 a side elevation. Both full size.

It will be noted that but one pattern is required, as both halves are alike. The joint is as indicated in the yoke, and the two halves are fastened together by long screws as shown by the dotted lines. It makes a neater and better job to counterbore for the heads of the screws, as shown in Fig. 1, so as to sink the screw heads down flush.

It will be noted that the outside end of the yoke and the outside face of the pole piece are in the same plane, and parallel to the axis of the waist. This is done purposely to get a true bearing surface to bolt against the face plate while the joint in the yoke is being faced off. This can be readily done in the lathe, and if the pattern and casting are made so as to be as shown in the drawing, the joint will be square and fair, and the link of the magnet be parallel where fastened together.

This having been done, the polar space may now be bored out. The end of the pole piece and the end face of the yoke are again in the same plane, so as to give a true surface to bolt against the face plate, so as to bring the bore of the polar space true and fair at right angles to the axis of the magnets, both ways. This all readily explains itself, and is only mentioned to account for the exact shape of the pattern, which may or may not be followed as one chooses, if one has some other way of jointing the face for the yoke joint or boring the polar space.

The armature next claims attention. It is shown in end view in Fig. 1, and the detail of construction is given in Figs. 3, 4, and 5. It will be seen that it is of the shuttle type, but instead of being of cast iron, and of the usual construction, it is made of the best of wrought iron, as follows:

The curved pole pieces are cut from a piece of wrought iron water pipe that has been first turned off and bored out to about the right size. This tube need not be turned down to size at first, but left a little large, to give stock enough to allow of turning off dead true after the whole is put together.

The shaft and center piece of armature are as shown in Figs. 3 and 4, forged in one piece from wrought iron and then turned up and finished. The flat part should fit into the tube snugly. Can then be fastened in by the screws as shown in the dotted lines, the spaces cut away, and then the curved face turned down to exact size. Besides the screws, the curved faces may be fastened by brazing if so desired.

This gives a good armature, and of much simpler form than the usual construction with brass ends. It will hold a good quantity of wire, and in every way gives good results for so small a motor.

The commutator and its insulating sleeve are shown in Figs. 6, 7, 8. This is a little varied from the usual construction. An ebonite sleeve with flange at one end is got out to fit upon the armature shaft, a good snug fit. (See Fig. 7.) A brass, bronze, or copper sleeve, with flange, is got out to slip snugly upon the ebonite sleeve. (See Fig. 8.) The two flanges are then fastened together by small screws as shown in Fig. 6, the screws coming through the ebonite flange and tapped into the brass flange for greater strength, and so as not to have any screw heads in the way on the face of the brass flange. After being fitted to place and marked, the brass sleeve is to be taken off and sawed apart into two parts, as shown, and the halves then replaced and fastened. This gives a good form of commutator for small work.

Figs. 9 and 10 show a form of stud that can be used to support the bearings, Fig. 9 being for the back bearing, and Fig. 10 for the front or commutator side. They are of brass, cut with screw threads up to a square shoulder, as shown, and are intended to screw into the ends of the polar extremities. The bearings themselves, shown in Figs. 11 and 12, are also of brass, and are intended to slip over the projecting ends of the studs, and to be held down by small nuts.

These studs can be made as ornamental as one pleases, the one essential being observed to have square shoulders to bring them fair and square with the polar faces, which latter, by the way, should have been faced off when the armature space was bored out. The bearings will then be fair and square with this bore, and the armature run true and without binding.

Of course, if one chooses, regular bearings can be cast, and then worked out of the solid, as in larger

motors. But in small work like this the method given gives excellent results, and is far simpler to make.

The brush holder is of the usual form. It is supported upon the boss of the front bearing, a groove being turned in this bearing as shown in the dotted lines in Fig. 13, to form a seat for the binding screw.

Figs. 13 and 14 show end and side views of a form of arm for the brushes that even in large work is simpler to make than the usual mortised arm.

It is turned up out of brass rod, and then filed or milled down to give a flat face. A piece of heavy sheet brass is then cut out and fitted to this flat face with small screws as shown. This gives a good clamp in which to secure and adjust the brushes. Figs. 13 and 14 are not drawn to scale, but are simply given as a simple way of making a brush arm.

A brush holder can also be very simply made without any casting by first turning up a brass ring from a piece of rod or tube to fit the boss upon the bearing. Arms are then got out of pieces of brass rod cut with a screw thread and square shoulder at one end, the ring being drilled and tapped at diametrically opposite sides to receive these arms. The faces of the ring where the screw holes are can be milled or filed down flat to give a bearing for the shoulders of the arms, or can be counterbored for the same purpose. The arms can then be screwed home tightly, and permanently fastened with solder, any surplus being finished off. The ends of the arms are then to be milled or filed down flat parallel to the plane of the ring, and drilled to receive the ebonite insulators that surround the brush arms. This method gives a finished brush holder that can be finished and polished all over in the simplest way, without the trouble in filing and scraping that attends working a brush holder out of the solid. See Fig. 15, where one arm is shown detached, the other fastened in place.

The motor is now ready for winding, and this is done in the usual way, the waists of the magnet first being covered with cloth laid on with shellac in the usual way.

The field magnet may be wound with five layers of No. 18 wire. The armature being wound full of No. 18 or No. 20, for series winding, which is probably the best for so small a motor.

A word as to the usual method of winding wire. The amateur will find that he will get better results if he winds at a slow speed. The hand should be protected with a heavy glove and the wire allowed to slip under the thumb with a constant strain upon the forefinger,

so as to bend the wire slightly *convex* toward the part being wound upon. This assures that the wire will lie *tight and flat*, and it needs to be tight and flat to get the wire on evenly. The slight convexity forces the middle part of the wire down snug. Whereas, if the wire is allowed to be slightly *concave* toward the magnet, the middle of each turn rides up from the magnet loosely, the only snug parts being where it bends around the edges.

To fasten the ends after the winding is complete, I find the best way to be to lay on a piece of tape when there are but six or eight more turns to take, take one turn over it and then fold the other end over to make a loose loop. All the last turns are then taken over this doubled tape, and when the last turn is taken the wire is cut so as to give the length of end required and then tucked through the loop, this loop being then drawn tight by pulling upon the top end that was purposely left projecting when laid over to wind upon.

Stout tape will readily draw up without any damage to the insulation. This gives a neat and snug fastening. The loose ends are to be cut off, of course, after the loop is drawn tight.

A little motor like the one described will be found powerful enough to readily drive a ten or twelve inch four-bladed brass fan, and to give a good breeze. This with six small cells of plunge battery.

The writer has had such a motor in use for two or three years, every summer, to drive a fan, with the most satisfactory results.

For fan work the motor should be mounted upon an upright pillar with a broad stand for a base. A brass plate may be fastened to the bottom of the polar extremities and the top of the pillar be secured into this plate.

This makes a readily portable fan, that with its battery can be readily moved from place to place as desired.

The terminals may be made fast to binding screws set upon a piece of ebonite and fastened to the side of one of the polar extremities. This gives a neat finish, and obviates the necessity for any wooden or other base except the pillar already mentioned.

If so desired, a drum armature can be made for a motor of this size. The writer has one with a drum armature with twelve coils of wire, size twenty. It works beautifully. The usual method of building drum armatures was followed, iron washers being used from which to build up the body of the armature.

A double-ended motor of the same size as the drawing may also be made, that is, each waist the same size as those in the drawing.

This gives a good motor. The writer has one with which he has run a Domestic sewing machine successfully, though it is too small for such use except under the most favorable circumstances.

With six 6-pint cells of plunge battery, zincs $4\frac{1}{2} \times 1\frac{1}{2}$, and double carbons same size, when freshly set up, enough power was developed for the sewing machine.

By careful work the amateur may be sure of a good motor of small size by following the drawings and description.

RENAULT'S DRY BATTERY.

PROF. RENAULT, of the Paris Museum, has just invented a new dry battery, very elegant in appearance and very practical. It consists of a vessel made of retort carbon, and in the bottom of which there is chromic



THE RENAULT DRY BATTERY.

acid mixed with gelatinous silica, which possesses the remarkable property of absorbing sixty times its volume of water. This mixture constitutes the active part of the battery.

This part is isolated from the rest of the apparatus by a pipe clay disk supporting a zinc spiral, z, containing simple gelatinous silica in its convolutions.

The mode of operation is easy to understand. The action of the chromic acid is exerted upon the zinc in passing through the disk, and produces a current.

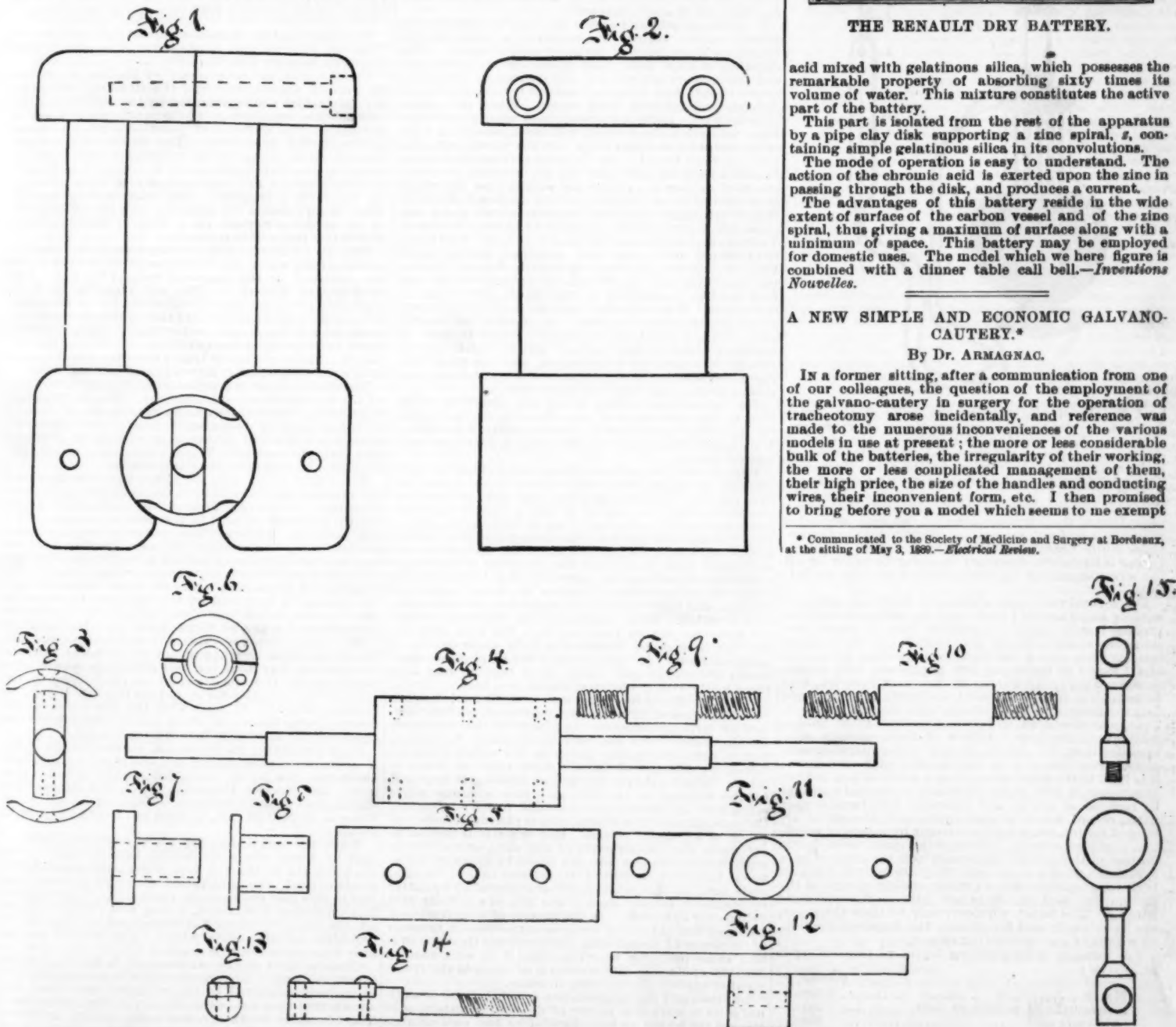
The advantages of this battery reside in the wide extent of surface of the carbon vessel and of the zinc spiral, thus giving a maximum of surface along with a minimum of space. This battery may be employed for domestic uses. The model which we here figure is combined with a dinner table call bell.—*Inventions Nouvelles*.

A NEW SIMPLE AND ECONOMIC GALVANO-CAUTERY.*

By DR. ARMAGNAC.

In a former sitting, after a communication from one of our colleagues, the question of the employment of the galvano-cautery in surgery for the operation of tracheotomy arose incidentally, and reference was made to the numerous inconveniences of the various models in use at present; the more or less considerable bulk of the batteries, the irregularity of their working, the more or less complicated management of them, their high price, the size of the handles and conducting wires, their inconvenient form, etc. I then promised to bring before you a model which seems to me exempt

* Communicated to the Society of Medicine and Surgery at Bordeaux, at the sitting of May 3, 1889.—*Electrical Review*.



SIMPLE ELECTRIC MOTOR FOR AMATEURS.

from all these inconveniences, and which is shown in the accompanying figure. I have used it for ocular cases for several years, and I can assure you that its working is as simple as convenient. Its construction is so little complicated that each of you might manufacture one for yourself, as I myself manufactured the one I am now presenting to you. It only cost me 13 francs—a consideration of some importance.

As you see, I had no need to go to much expense in constructing the battery. I simply took an ordinary Grenet battery (bottle type) of two liters, with two zincs, and I connected, by a cross piece of copper furnished with a ring, the rods supporting the two zincs, so as to be able to plunge them simultaneously into the solution of bichromate of soda or potash contained in the bottle. This arrangement enables us to obtain the whole effect of the battery, from the minimum to the maximum of power, by simply lowering the zincs more or less. If we wish to heat to red heat a very fine strip of platinum, we have merely to plunge the zincs into the exciting liquid to the depth of one or two centimeters; by completely submerging them we may easily heat to red heat over one centimeter of its extent a wire two-thirds of a millimeter in diameter.

So much for the battery. We will now examine the handle that holds the cauteries. You know that in the various models of galvano-cauterics of commerce, each knife, or slip of platinum, is mounted upon a support which itself fixes upon the handle. Thus as many of these accessories are required as there are cauterics used, and, however varied these may be, the surgeon may, unexpectedly, require a special arrangement adapted to a particular case; he is then at the mercy of the manufacturer, who is not always within reach or at his disposal.

With the holder that I have the honor to submit to you, there is no need of manufacturers of cauterics. With platinum wire of different thicknesses, a pair of pincers and a hammer, the surgeon can in a few seconds improvise cauterics of infinite forms, fixing firmly and conveniently on the same handle. He thus gains not only in economy, each cauterie costing merely a few centimes or a few sous, but he is also rendered independent of the manufacturer, since he can modify his cauterics at will according to his requirements.

The holder that I have manufactured myself, for my own use, has one little inconvenience, it has no interrupter of the current, so that it does not enable one to

nevertheless it can be utilized as it is. The incandescence of the platinum wire does not last long, a few minutes only; but by raising the zincs from time to time we may produce a series of incandescences, the total duration of which exceeds several hours.

In submitting my model to you, I do not expect it to take the place of the various models in use, some of which are excellent and very powerful. I merely wish to show the advantage of using a battery that can be obtained anywhere, and which has the additional recommendation of only costing 12 francs. I beg also to call special attention to my cauterie holder, which constitutes the original part of my apparatus, since it enables any one to make for himself his platinum slips or knives, and it can be employed with all the batteries at present in use for galvano-cauterizing.

Up to now I have only used my apparatus for slight optical cases; but its application might certainly be greatly extended, for a slip of thick platinum wire $\frac{1}{2}$ of a millimeter in diameter is sufficiently resistant to make a deep puncture or an incision, and it could, if required, burn through a thin board.

(THE RAPID GAZETTE.)

THE DERMATOLOGICAL VALUE OF SULPHOLEATE OF SODIUM.

OINTMENTS and liniments have been applied to the skin since the earliest days of medicine, and it seems strange that an experience of so many centuries should have produced no change in their composition, for, until quite recently, the base has remained the same, namely, some animal or vegetable oil or fat. In recent years other bases, such as glycerite of starch, vaseline and lanolin, have been recommended, and to a certain extent adopted, as substitutes for the time-honored lard, but their advantages have been either slight or offset by some objectionable quality.

Some years ago Dr. George Henry Fox called attention to sulpholeate of sodium, which, while not wholly free from objections, possesses certain properties which render it of great service in the local treatment of skin diseases, and in the *Journal of Cutaneous and Genito-Urinary Diseases* for May, 1890, he contributes a paper which is the result of his long-continued experience with this substance.

When sulphuric acid is added slowly to any fixed oil or fat, care being taken to keep the temperature of the mixture below a certain point, a chemical combination is formed, the oleic acid being transformed into what has been called sulpholeic acid.

If sulphuric acid and castor oil, e. g., be mixed in the manner above stated, the result is a thick, viscid, brownish mass, with a strongly acid reaction. The chemical change must take place slowly, and to this end the mixture is kept cool and frequently stirred for about twenty-four hours, or until it is perfectly homogeneous and miscible with water. When the sulpholeic acid thus obtained is combined with an alkaline base, we have a clear, thick, yellowish, semifluid mass of the nature of a liquid soap. Of the various alkalies, soda has been found to be the most serviceable in combination with the acid, and the preparation of sulpholeate of sodium is, in brief, as follows: To the viscid mass formed by combination of the acid and oil a solution of carbonate of sodium is slowly added under constant stirring and the sulpholeate of sodium is formed. This mixture is allowed to stand for twenty-four hours in a funnel, with stop cock attached, during which time two distinct layers are gradually formed, the upper one being the sulpholeate of sodium, which is at first held in suspension in the liquid, like cream in cow's milk. This substance has an acid, bitter taste, and a nearly neutral reaction. Applied to the healthy skin, it has a bland, oily or slightly sticky feeling. It contains about 80 per cent. of water, which can be readily separated by evaporation, and the mass then resembles vaseline in appearance and consistency, and makes an excellent basis for ointments.

The value of sulpholeate of sodium, according to Dr. Fox, in the treatment of skin diseases, depends upon the following qualities: 1, its miscibility with water; 2, its rapid absorption by the skin; 3, its remarkable solvent power.

The ease with which anhydrous sulpholeate of sodium can be mixed with water gives it an advantage over the fatty substances commonly used for application to the skin. It makes, in fact, a soluble ointment—one which can be washed from the skin as readily as it can be smeared upon it. In cases where it is not desirable to keep an ointment upon the skin both day and night, those made with lard, vaseline or lanolin as a base are objectionable, since the effort to remove the greasy substance often requires the use of soap and friction, and thereby tends to aggravate an inflammatory eruption. With sulpholeate of sodium as a base, the ointment can be removed from the skin with the greatest of ease by means of a little water or even a moistened rag. In this respect the sulpholeate ointments are unlike any which have been in use, save those made with glycerite of starch as a base.

It is this affinity for water which enables sulpholeate of sodium to sink into the skin more readily than vaseline or fatty substances. In regard to the best basis for ointments, there has been considerable discussion, but, in determining this question, the object to be attained by the use of the ointment must be borne in mind. When a simple protective dressing is required for the surfaces of the skin, as e. g., in a case of acute eczema of an infant's face, vaseline or its equivalent, the petrolatum of the United States pharmacopoeia, will prove of excellent service. But when it is desired to act upon the deeper parts of the skin, or to convey medicinal substances into the blood by means of cutaneous inunction, vaseline is far inferior to lard, lanolin, oleic acid, or the sulpholeate of sodium. The latter substance is largely used in the arts as a solvent and vehicle for dye stuffs. In the process of wool dyeing it has been found to be of the greatest service on account of its power of penetrating the keratinic tissues. It is this same property which enables it to sink readily into the epidermis, and renders it of value in the treatment of various chronic skin diseases.

But the chief recommendation of sulpholeate of sodium is its remarkable power of dissolving certain substances for which we have heretofore had no available solvent. Sulphur, chrysarobin, and other drugs of great value in dermatology have heretofore been applied to the skin in a finely triturated but undissolved

condition. Such drugs have, therefore, exerted their action solely upon the surface of the skin, except when friction has forced them mechanically into the follicles, where perhaps a certain amount of absorption has taken place. The beneficial effects of these drugs thus applied cannot be disputed, but when we consider that sulpholeate of sodium will dissolve at least 2 per cent. of sulphur or of chrysarobin, their increased efficacy can readily be imagined. Other substances commonly used for application to the skin are readily dissolved in any desirable quantity.

There are three forms in which sulpholeate of sodium may be advantageously used in the local treatment of skin disease: 1, as an unguent; 2, as a liniment or liquid application; 3, as a plaster.

As a basis for ointments, the watery element must be removed by evaporation until a suitable consistence is attained. As this process necessarily involves time and trouble, the ointment thus prepared will be more expensive than those made with lard or petroleum as a basis, and in most cases will possess no corresponding advantage.

As a liniment, employed for the purpose of conveying various medicaments into or through the skin, the hydrated sulpholeate of sodium has proved in Dr. Fox's experience superior to any substance which we now possess. While it sinks into and softens the skin like glycerin, by virtue of its hygroscopic property it has the additional and important advantage, already mentioned, of dissolving and carrying various substances with it.

Mixed with gelatine in proper proportions and spread thinly upon muslin, sulpholeate of sodium makes a plaster which adheres readily to the skin when moistened, and is superior in many respects to any heretofore used.

Theoretically, the sulpholeate of sodium is a substance of neutral reaction, and perfectly bland when applied to the skin. Practically, it will be found, especially when carelessly made, to contain a little free acid, and may thus produce a slight amount of irritation when applied to a delicate or acutely inflamed skin. Dr. Fox admits that in the treatment of acute infantile eczema, where one might hope for the best results from the use of soluble ointment, he has only met with disappointment, but in the use of all stimulating applications he has found sulpholeate of sodium to be a vehicle of the greatest service.

THE GROUND WATER AND DRINKING WATER THEORIES OF THE ETIOLOGY OF CHOLERA.

THE following is translated from the *Annales de l'Institut Pasteur*, and published in the *Abstracts of Sanitary Reports*, July 25:

The theories of the etiology of cholera, known as the ground water theory and the drinking water theory, and which are represented by the Berlin and Munich schools, continue to excite much controversy in Germany. The question of practice is the animating motive of the discussions. The theory which attributes microbe disease to the transmission of germs by means of drinking water is clear, simple, and definite in its indications, and, consequently, in the prophylactic measures it suggests. The Pettenkofer or ground water theory makes the evolution of a sporadic case or of an epidemic depend on a host of factors against which it is impossible to guard.

The city of Munich has a strong underlying body of subterranean water, the variations in the level of which are constant in the numerous wells of the city. The epidemic at Munich in 1854 was preceded by a remarkable elevation, and accompanied by as remarkable a depression of the level of this subterranean water. According to the ground water theory, a close relation exists between these facts and the evolution of the epidemic. The variation of level allows the water to permeate the soil, which it leaves humid on subsidence.

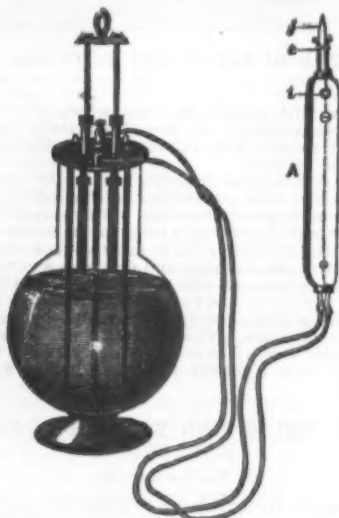
The danger point is reached when the soil has attained the requisite degree of humidity. The cholera germ is innocuous when it leaves the human organism, and to infect another organism it must mature and complete a new phase of its existence outside of man and in a suitable medium. The medium is the soil, moist, aerated, and saturated with impurities.

The school represented by Koch objects to this that the maturation of the cholera germs in the soil is purely subjective, and that none of the pathogenic germs known offer any parallel to the conditions claimed for the germs of cholera. The germs of smallpox and scarlet fever pass directly from one patient to another, and one individual may initiate an epidemic. The bacillus anthracis is not only virulent when it leaves the organism of the animal whose life it has destroyed, but its virulence is increased by transmission through the same species, as has been demonstrated by the studies in septicemia made by Coze, Feltz, and Davaine. It is true that anthrax is sometimes of telluric origin, and Koch has shown by what means the virulent microbe is conserved, but there is a vast difference between the possibility of the conservation of the bacillus in the soil and the necessity for it to pass through the soil to become virulent. It rests with the advocates of the ground water theory to show the mechanism for the exodus of the morbid influence from the soil.

Vogt attributes its liberation to oscillations in the pressure of the atmosphere, and the expulsion has been accounted for by an elevation of the subterranean level. But Noegeli, Pumpelly, Renk, and Miquel have shown that passage through a layer of humid earth filters a current of air, instead of charging it with germs.

When the soil is dry, the air current may take up dust in which there are germs, and attrition under the influence of the sun and wind may create whirlwinds of dust, the respiration of which is dangerous. But in this case the microbe must support desiccation, and supposing it retained, living and virulent, in the air, the means by which it is introduced into the human organism are left undetermined. The way of pulmonary inhalation must be rejected.

Cholera, as at present understood, is localized in the intestinal canal. The germs might be arrested by the saliva and conveyed to the stomach, but Koch has shown that they can support only a short stay there. The advocates of the ground water theory, however, accept penetration of the germ into the organism by way of the saliva, and reject the transmission by food and water.



heat the slip of platinum or the knife at the exact moment required. This is sometimes of grave importance. With children, for instance, the red hot platinum is a source of terror, and not without cause, if the cauterie is to be applied to the eye. Moreover, with a holder that works constantly with a closed current, the surgeon is not able to moderate or intensify the incandescence of the cauterie, and we all know that according to the circumstances of the case, we prefer sometimes dull red, sometimes glowing red, and sometimes white heat. A holder furnished with an interrupter is therefore necessary in order to profit by all the advantages that my instrument is capable of offering.

For several years, not wishing to make my galvano-cauterie known until I could also say where it could be procured well made, I applied in vain to many constructors without being able to find one that would put my idea into a satisfactory industrial form. At last I found at Bordeaux two gentlemen who volunteered to supply my wants: M. Mouroux, optician, who undertook to furnish me with the bottle battery, coupling the zincs, and M. Gendron, who, under my instructions, manufactured a very convenient little holder with an interrupter. Either of these makers will, henceforward, be able to supply the apparatus complete. The holder, A, is very slender and very light; it is held in the hand as easily as a knife or pen holder. It consists of two plates of ebony, connected together by ferrules or screws, and inclosing two large copper wires, one of which is continuous and the other arranged for interrupting the current by means of a button, *f*, placed outside. These wires pass through the bottom of the handle into conductors terminated by a cylinder. At the upper part they are hollowed out on their inner surface into a groove, ending at each of the extremities, and in these are placed the platinum wires, *g*. The latter, whatever may be their thickness, are fixed easily and firmly into the required position, by means of a simple sliding ring, *c*.

The formula of the exciting liquid of the battery is as follows:

	Grammes.
Water.....	2,000
Bichromate of potash or soda.....	250
Sulphuric acid.....	300
Hydrochloric acid.....	200

The ordinary Grenet battery of commerce certainly leaves much to be desired as regards construction,

Dr. Hueppe, in a recent work, has undertaken to find a common ground on which the two theories may meet. His conception is that the cholera bacillus may, like most pathogenic bacteria, exist in the saprophytic state. Frankel has demonstrated that it finds in the superficial layers of soil the necessary conditions of temperature, that it resists desiccation and putrefaction and the rivalry of other species.

It leaves the soil not matured, as Pettenkofer claims, but vigorous and capable of resisting the action of the gastric juice when, by deglutition of saliva, respiration, drinking water, or alimentary substances, it has reached the stomach. It develops in the intestinal canal, producing the toxic agents that impart to cholera its frightful character. When it leaves the human organism it ceases to be infectious, and recovers its virulence by contact with the air or in the soil. If air and oxygen are deficient, the germ perishes. If both are present in small quantities, it can lead an aerobic existence at the expense of the materials it encounters.

GOLD AS A THERAPEUTIC AGENT.

By C. J. S. THOMPSON.

THE use of gold as a medicinal agent is of considerable antiquity, dating back to a very early period, and like mercury, whose action it much resembles, it was accounted of great value by the alchemists of old.

Centuries ago, both precious metals and stones were credited with wonderful healing properties, and the diamond, the sapphire, ruby, and amethyst were supposed to have marvelous virtues. The apothecaries of the seventeenth century used it largely as a stimulant, also in the treatment of epilepsy, and it entered as an ingredient into many of their compound elixirs and other preparations.

Culpeper, in his *Physician*, says: "Gold is temperate in gravity. It wonderfully strengthens the heart and vital spirits. In cordials it resists melancholy, faintings and swoonings, also fevers and falling sickness, and all such like infirmities, incident either to the vital or animal spirit."

An ancient poet quaintly remarks:

"For gold is cordial, and that's the reason
Your raking misers live so long a season."

Down to the very early part of this century it was included in most of the pharmacopoeias of Europe, and was prescribed largely for syphilis. But like iusk and other expensive remedies once frequently employed in medical practice, the internal administration of the precious metal has almost entirely dropped out of use.

The physiological action of the salts of gold may easily be tested, and it is also stated to have diaphoretic properties. It was frequently used by medical men fifty years ago in the treatment of syphilis, many of whom believed it superior to mercury in severe cases.

One of the oldest preparations of gold was known as *crocus solis*, and prepared in several ways. The *crocus solis* of Germany was directed to be made by first making an amalgam, composed of one part of gold and six parts of mercury, and triturating it with twice its weight of sulphur. It was then heated in a crucible till the mercury and sulphur became dissipated, and the gold remained in the form of a brown powder. Another method of preparation, also, was by precipitation, as follows:

℞ Divided gold.....q. s.
Acid, nitro-hydrochlor.....q. s.

To dissolve the metal, dilute the acid solution with twelve parts of water, then add a solution of potash to excess. Wash and dry the precipitate thrown down.

A frequent old fashioned method of administering a preparation of gold was by rubbing it into the gums or over the tongue.

Crocus solis formed the base of several preparations, such as Kornmann's panacea, in which it was combined with hydrargyrum sulphureum and oil of cinnamon, also golden hartshorn, that had great reputation as a cordial and sudorific, and was composed of *crocus solis* and prepared hartshorn.

The stannate of gold, well known as the purple of Cassius, was formerly prescribed internally, to be taken in progressive doses of $\frac{1}{16}$ to 1 grain, from $\frac{1}{8}$ to 1 grain being also recommended to be rubbed over the tongue. The metal itself was used in the form known as divided gold, made by forming an amalgam of mercury and gold leaf, in parts of one to six, the mercury being taken up by hot nitric acid, then dried, and the residuum pulverized.

Divided gold was administered in doses of $\frac{1}{2}$ to 5 grains, daily, by rubbing on the gums. It was used also to make the sirup of gold, a preparation recommended in lotions for application to syphilitic ulcers. The formula is given as follows:

℞ Divided gold.....34 grains.
Simple or gum sirup.....℥ j.

Mix intimately.

The chloride of gold was once frequently ordered in medicine, and usually given in doses of $\frac{1}{16}$ to $\frac{1}{4}$ of a grain daily, and was also used in making the pills. Combined with starch it formed the powder of chloride of gold. The tinctura auri was a somewhat expensive preparation, and made in the following manner:

℞ Pure gold.....3 j.
Acid, nitro-hydrochloric.....℥ j.

Dissolve and add

Ol. rosmar.....℥ ij.

Set aside until the color of the acid disappears, then add

Rectified spirit.....℥ viij.

The dose of this tincture was from 5 to 10 drops. Another form was aurate of ammonia, known as aurum fulminans. It was made by precipitating divided gold from solution in nitro-hydrochloric acid with ammonia, and was prescribed as a diaphoretic, in doses of from three to six grains. It was used in the preparation of the balsam of gold made by dissolving one part of aurate of ammonia in four parts of oil of juniper.

A popular remedy largely used in Continental countries was known as General La Motte's drops, and consisted of aurate of ammonia dissolved in nitric acid, and diluted with rectified spirit. It was regarded as a sovereign remedy in more senses than one.

The bromide of gold has been recently prescribed by several medical men in cases of epilepsy with success. It is given in doses of one-sixteenth to one-tenth of a grain. So it is quite probable we may see gold again come into use in medicine, and its preparations once more on the shelves of the pharmacy.—*Pharmaceutical Journal*.

AGRICULTURAL DEPRESSION.

MR. C. S. RICK, of Lowville, N. Y., writes as follows in the *Rural New-Yorker*:

There are no deserted farms in this vicinity, but many farmers have the spirit of deserters, and are ready to join in the general cry about the low prices of dairy products, and the depreciation in value of farming lands. Perhaps it may be well to recall some earlier experiences, and inquire whether the former days were really better than these.

During the war, and for years after its close, high prices prevailed through depreciation in the value of the paper money when compared with gold, the real standard. As no one wishes or expects a return of civil war, it would be useless to institute a comparison between that period and the present. A state of war is not a normal one, and our country is still suffering from its evil effects. In sympathy with the premium on gold, farming lands advanced in price from 50 to 100 per cent., and farmers who had possessed real capital to the amount of \$5,000 suddenly advanced in apparent wealth to \$8,000 or \$10,000. Some sold their farms and retired from business. Others continued farming and paid debts while the inflation lasted. Nearly all began a course of more expensive living in keeping with what was supposed to be greatly increased capital, sure to produce a corresponding increase of income. Custom has with many all the force of necessity, and a return to the simpler ways and cheap living of former times is regarded as an impossibility. Through changes in the currency and competition with the large amount of cheap, fertile Western land lately brought under cultivation, it cannot be denied that farms in New York have decreased in value until they are now worth no more than they were before the war. The general wail of farmers over the low price of farm products has accelerated this depreciation and forced the value below reasonable limits. They have decried their own property by joining in the declaration that "farming does not pay." It is true that if a man bought high priced land several years ago, and it is still heavily mortgaged, his prospects are not very encouraging; but when there is little or no debt, a family with a homestead farm, fairly well situated, need not raise the question of value per acre. If the fertility of the soil has been maintained, advance or depreciation in price is of no great importance to the permanent owner.

If the present is compared with a former period, the prices of farm products and the amount of necessary farm expenses are the principal items relevant to the inquiry. In the year 1833 the first cheese that found a market beyond the limits of the county was made in Lowville. It was made from a dairy of 15 cows and was kept through the season. In the fall the dairyman learned that his butter and cheese could be sold for cash in Rome, 42 miles distant. He accordingly loaded them into his wagon and drew them to that market, and there sold the butter for 9 cents and the cheese for 5 cents per pound. He returned home so well pleased with the result of his venture that he took measures to increase his dairy to 30 cows for the next year. He was for many years a successful dairyman and amassed quite a respectable fortune in the business. He and his wife made every dollar that they possessed by the labor of their own hands and brains, and, of course, used good judgment in the management of their affairs. This fact is mentioned to show that the business of dairying was more promising than any other at that time. It is evident that if this had not been so, this wideawake man would not have engaged in it. Farmers had tried raising peppermint and distilling oil from it, but after a considerable amount had been expended in building stills, and one or two crops had been sold at a fairly remunerative price, it was found that there was an over-production of oil and the business was soon abandoned. About the time of the introduction of cheese dairying, wool was largely produced here. Large flocks of sheep were kept on nearly all the farms in this vicinity. There was no market for mutton, and as nearly all the sheep died a natural death, the only profit derived from them was from the sale of the wool.

It is manifest that Mr. Bowen when he drew his first cheese to Rome and received five cents per pound for it, was engaged in the best paying business of that day. Think of this, ye discouraged dairymen of today! Five cents per pound for cheese after keeping it through the summer and drawing it 42 miles in a wagon with the mud in many places a foot deep, was not a very great price; but Levi Bowen, a man of sound sense and marked ability, came home from that sale with a face radiant with smiles, and telling every one of his good fortune, went to his work with fresh courage and increased energy. From this small beginning cheese dairying soon grew to be the leading industry of the county and has continued to be such for more than 50 years. Cheese was sold for five cents in 1833. A fair dairy of cheese was delivered at Rome in the year 1849 for \$4.62 per cwt. In 1852 cheese sold for 6½ cents per pound. At no time previous to 1860 did milk manufactured into cheese bring better net returns than it did last year. Eighty cents per 100 pounds of milk was about the average price received by dairy men last year. This is far better than the average of the 20 years between 1840 and 1860. Beef was sold from my farm last year for a higher price than was realized at any time before 1860, and the price of pork was above the average of 20 years previous to that date. Colts have brought 50 to 100 per cent. more during the last four years than at any time before the war. Formerly there was only a limited market for potatoes, and they seldom brought more than 20 or 25 cents per bushel in Lewis County. In 1849 a good farm hand could be hired for eight months

for \$12 per month, and in 1850 for \$18, and in 1861 for \$15. The same class of help was hired this season for an average of \$18 per month. This is an increase of about 50 per cent. in the cost of hired help but for 10 years the greater net profit on the potato crop alone, through better facilities for marketing the same, has more than paid the increase. Railroad freights are higher than they ought to be, and farmers justly complain; but potatoes raised on my farm last year brought 20 cents a bushel more than they would if the canal were the only available method of transportation. Of course this view of the subject is wholly local and limited in its application; but it is a matter of experience. Hired help is perhaps the only item of necessary expense that costs more now than before the war. Coffee is higher, but it is not generally regarded as a necessity, and was but little used in former times. It is also true that whisky is more costly, but I am happy to know that representative farmers have no use for that article.

Farmers expend more for implements than formerly; but tools were never so cheap as at the present time. The opportunity to purchase and use labor-saving implements and machinery is really a very great advantage enjoyed by the farmer of to-day. If he makes the best possible use of improved tools, and so enres for them as to secure their durability, greater profit may be realized through this outlay. If the large amount paid out for tools is a disadvantage to the farmer, perhaps he would better go back to the hand scythe, the hand rake and grain cradle, to the hand fork for unloading hay, and the flail for thrashing grain, and give up the use of cultivators, improved harrows, grain drills and the whole catalogue of implements unknown to agriculture 50 years ago.

In this vicinity well managed farms are as productive as they ever have been. Prices of farm products average higher than they did for a period of 20 years before the war. Necessary farm expenses are not greater than they were then; but family and personal expenses are much larger, and herein is found the principal reason why farmers cannot now save money as they formerly did. Comfort seems to require that a farm house should be carpeted throughout; but, after all, it is a necessity only as custom makes it such. Formerly if there were one spare room in the house and that was carpeted, the requirements of custom were fully met. That one carpet was usually the handiwork of the farmer's wife, and involved no cash expense except for carding the wool and buying coloring material for the yarn. Time and space forbid that I should more than mention the costly furniture, the splendid musical instruments, the fine carriages, sleighs and harnesses that illustrate a class of expenses which custom proclaims necessary to present farm life. While it may be neither desirable nor practicable for the young farmer to go back to the frugal habits and simple life of his father, it is the height of folly to let fashion dictate expenditures of the class above mentioned beyond what assured income warrants. Enjoyment of life does not necessarily depend on these things. The universal testimony of successful and wealthy farmers who have become such through years of toil and strict economy is that they enjoyed life as well during that period as subsequently when living in fine houses and in a far more expensive way. Farmers, as a class, are quite as well situated to enjoy life as the average of those engaged in other occupations, and their numbers are such that when perfect combination is secured, their rights will be protected and they will be able to reap the full benefit of their toil. Meanwhile, by attending to his business carefully, by breeding and keeping improved stock, by adopting the best methods of cultivation, and practicing strict economy, the farmer may retain his home and add something to his capital each year. But the farmer who spends his time shouting that "farming don't pay," that farms are all mortgaged, that farming land is not worth anything, in short, that agricultural bankruptcy is impending over the whole country, will probably succeed in making himself quite unhappy and bringing about still further reduction in the value of his property.

NOTES FOR CHEESE MAKERS.

By JAS. W. ROBERTSON, Dairy Commissioner.

CHEESE FACTORIES AND THEIR SURROUNDINGS.

1. The present, not next week, will be the best time to see that all the drainage facilities of the factory are adequate and in good working order.
2. Whey runs, spouts and tanks should be put into such order that leaking will be prevented.
3. If there be a leakage anywhere from floors, spouts or tanks, which is not immediately preventable, provision should be made at once for the drainage of the waste, if only by shallow open trenches. A liberal supply of lime and gypsum should be spread around such places. Don't fail to secure a barrel or two of each, for use during the hot weather.
4. If the factory buildings are not painted and will not be painted, get them whitewashed this month. If you cannot get that done by the proprietors or managers, get permission and do the rest yourself. A whitewashed curing room of imperfect construction can be kept 10 degrees cooler in summer than one not whitewashed. If the cheese become injured, through excess of heat, neither the buyers nor the patrons will whitewash your reputation then, whether the blame belongs to you or not.
5. Make the surroundings of the factory neat and tidy. Plant a few trees and a great many flowers.
6. While keeping the outside of the premises as creditable to your taste and neat habits as possible, make the inside to reflect still more your aversion to everything untidy and dirty. Give every part of the factory a thorough cleaning and keep it in a sweet state all summer.
7. Before the curing room contains any cheese, fumigate it by burning some sulphur mixed in alcohol. That will help to prevent the growth of mould on the outside of the cheese.
8. The leisure hours of May, before the large flow of milk is received, should be employed putting all the apparatus, appliances, utensils and machinery into the best of working order.
9. Be sure that the making room floor is so well constructed and supported that it will not shake or vibrate during the coagulation of the milk.

MILK AND MAKING.

1. Procure a copy of "Milk for Cheese Factories" for each of your patrons by applying to the Dairy Commissioner, Central Experimental Farm, Ottawa, stating the number required and the address to which they are to be sent. They will be furnished free in French and English.
2. Look out for "leaky" flavors in the milk. Don't put such milk into the vat with that of the other patrons. If you have time, make it up by itself, and send the cheese from it to the patron who supplied that milk, for his private use.
3. Make provision for keeping a short record of each day's work, of the exceptional treatment of every vat and of the comparative quality of the cheese from each vat, before they are shipped.
4. Milk sours readily and rapidly for a number of weeks after the period of lactation in the cows begins. Hence milk seldom requires to be ripened for setting, during May.
5. Use enough rennet to coagulate the curd into a state fit for cutting, in from 17 to 30 minutes, at from 83° to 88° Fahr.
6. Cut it rather early, slowly and very carefully.
7. Use the horizontal knife first.
8. Afterward allow the curd to settle until whey comes over nearly the whole surface.
9. Then begin to cut with the perpendicular knife.
10. Immediately after the cutting is completed, begin to stir the mass slowly and continuously, until the curd is cooked.
11. Heat should not be applied until 10 minutes after the stirring is begun.
12. The heating should be effected gradually, at the rate of about 1 degree for every 4 or 5 minutes until 98° Fahr. is reached.
13. Draw most of the whey early, and so guard against being caught unprepared for the rapid development of acid.
14. Don't dip the curd until the presence of acid is discernible by the hot iron test. Sweet flavors result from too early dipping in May.
15. After dipping the curd, stir it gently and keep it at a temperature above 94°.
16. Don't attempt close matting, high piling or packing of the curd this month. See that the whey is separated from it.
17. When it begins to feel "slippy" and smells like fresh made butter, it should be put through the cutter or grinder.
18. Acid develops so rapidly that care must be taken to keep the treatment well in advance of the change in the curd.
19. After grinding or cutting, stir for 10 or 15 minutes before salting.
20. Apply salt at a rate of about 1½ lb., early in the month, to 3 lb. per 1,000 lb. of milk during the last ten days, varying the quantity slightly according to the condition of the curd as to its moisture.
21. Begin to put the curd in the hoops within 20 minutes after the salt is stirred in.
22. Use only pure water in bandaging.
23. Guard against the formation of edges or shoulders from the hoop followers being too small. Apply the pressure gradually until the whole power through the long lever is used, after four hours.
24. Leave the press cloths on, and turn the cheese in the hoops every morning. Let no cheese leave the press room until the shape is symmetrical and the finish neat.
25. Don't press the scaleboards on the ends of the cheese.
26. When the press cloths are removed, use hot clean whey oil or butter, into which has been dissolved a teaspoonful of soda per cupful of oil.
27. Try to keep the temperature of the press room above 60° Fahr.
28. The curing room should be kept at a temperature continuously between 65° and 70° Fahr.
29. Provide strong, smooth boxes of the exact size.
30. Stencil the weight of the cheese in neat figures on the side of every box.

LABYRINTHS.

THE term labyrinth serves to designate various structures, but all of which have one point of resemblance—the complication of their sinuous lines. In fact, the buildings, pavements, and gardens called labyrinths are formed of alleys that cross and intercross each other *ad infinitum*.

The authors of antiquity are full of descriptions of these wonderful structures, which served as tombs or religious temples. These sorts of structures, as well as their name, appear to have originated in Egypt, where was observed a labyrinth which has remained celebrated.

This was a structure, the exact purpose of which has not been established, although it is probable, according to Herodotus and Pliny, that it was within its walls that the principal initiations into the mysteries of the Egyptian religion were accomplished. What is strange is that nothing remains to-day of this congeries of edifices, and that we cannot, even approximately, fix the place where the labyrinth stood. It is necessary to believe that the largest portion consisted of sub-structures, which are now buried, and which, perhaps, some day will come to light like Herculaneum and Pompeii.

The one of all the structures of this kind that has been most celebrated by the poets is assuredly the famous labyrinth of Crete, erected by order of King Minos, to serve as a prison for the Minotaur. It was an open edifice, erected upon the ground, and the plan of it was drawn by the famous Dædalus from that of the labyrinth that he had seen in Egypt, near Lake Moeris; thus says tradition, and tradition only.

Perhaps this structure has existed in poetry only; perhaps, too, the external portion of it was destroyed in the Trojan war. Only the subterranean part remains—a cavern with deep, covered galleries, which was visited by our celebrated botanist Toumefort, nearly two centuries ago, and which still exists at the foot of Mt. Ida, in the island of Candia (formerly Crete). Toumefort's voyage to the Levant gives us a very curious description of it.

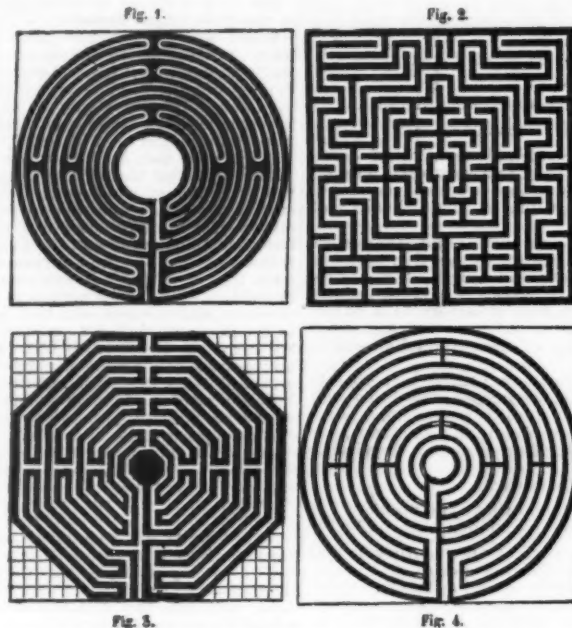
We shall say nothing of the labyrinths of Lemnos and Clusium, of which no trace now remains, and shall pass at once to church labyrinths—to those peculiar

arrangements of pavements that were applied in churches during the middle ages. The following is what Viollet-le-Duc says of them in his "Dictionnaire Raisonné de l'Architecture Française du Onzième au Seizième Siècle."

"It was customary during the middle ages to arrange in the middle of the nave of certain large churches pavements of white and black stones or colored flags, forming, by their combinations, complicated meanders, to which the name of 'labyrinth' or 'road of Jerusalem,' or 'league,' was given. We cannot say what the origin of these kinds of pavements was.

"Mr. Louis Paris, in his 'Mémoire du Mobilier de Notre Dame de Reims,' claims that these pavements were a reminiscence of some pagan tradition. That is

geria) exhibits upon its pavement a mosaic that might be taken for one of these labyrinths, that is to say, a complicated meander. Now, this basilic dates back to 338, as Mr. F. Prevost believes. Did this custom come from the East after the first crusade? Or is it a local tradition? We are inclined to think that the representation of the masters of the work upon these pavements connects them with some masonic symbol adopted by the school of laic masters, inasmuch as we do not see these labyrinths appear upon the pavements of churches until religious structures fell into the hands of this powerful school. Had these meanders been traced in order to represent the passage of Christ from the gate of Jerusalem to Calvary, we must believe that a religious sign would have recalled the stations, or at



FIGS. 1 TO 4.—LABYRINTHS OF CATHEDRALS.

1. Cathedral of Sens. 2. Cathedral of Saint Omer. 3. Cathedral of Saint Quentin. 4. Cathedral of Bayeux.

possible; yet no mention is made of any, either in Guillaume Durand or in the authors preceding him who have written upon church matters. The most ancient labyrinths of this kind that we know of are not anterior to the end of the twelfth century, and Seigneur de Caumont, in his 'Voyage d'Oultremer,' says nothing that can give credence to a tradition of this nature; that is to say, he establishes no point of comparison between the labyrinth of the Minotaur and those that he had evidently seen traced upon the pavement of the churches of his country.

"The labyrinth of the cathedral of Reims was called 'dædalus,' 'meander,' 'league,' or 'road of Jerusalem.' In these combinations of concentric lines, some archaeologists have chosen to see a play of the masters of the work, in taking as their basis the fact that three of these labyrinths—those of Chartres, Reims and Amiens—represent in certain compartments the faces of the architects who built these cathedrals. We shall beware of deciding the question. We find drawings of most of these labyrinths in the work of Mr. Amé entitled *Carrelages enluminés du moyen âge et de la Renaissance*.

"Mr. Vallet, in his description of the crypt of Saint Bertin at Saint Omer, shows that the faithful had to follow upon the knees the numerous windings traced by the lines of these meanders, in memory of the passage made by Jesus from Jerusalem to Calvary.

"The small basilic of Reparatus at Orleansville (Al-

least the last one. Now, we observe nothing like this in any of the labyrinths that are still extant or in those of which drawings remain to us.

"Moreover, we find glazed flags that represent combinations of meandering lines, of so small dimensions that it would surely be impossible to follow these complicated routes either on foot or on the knees, since some of these labyrinths, such as that of the church of Toussaint (Marne), are no more than one inch square.

"To tell the truth, these latter meanders date from the fourteenth century, and may pass for a copy of larger work; but, again, neither the small nor the large ones contain any religious sign."

Viollet-le-Duc's opinion is undoubtedly the only one admissible. The figures of the four most curious types of this kind, which we borrow from Mr. Ernest Bosc's "Dictionnaire raisonné d'architecture" (Firmin-Didot, 1879), will better convince us of this.

The labyrinth of the cathedral of Sens, Fig. 1, was of circular form, was inlaid with lead, and was 65 feet in diameter. The traced path was 2,000 feet in length, and it took nearly an hour to make the entire circuit of it. It was destroyed in 1768. It had a great analogy with that of the cathedral of Chartres, which is still named the "league." The latter has the same circular shape, but measures only about 730 feet in circuit up to its center. It is formed of blue Senlis stone.

In his description of the crypt of Saint Bertin, Mr. Vallet says that the labyrinth of Saint Omer was com-

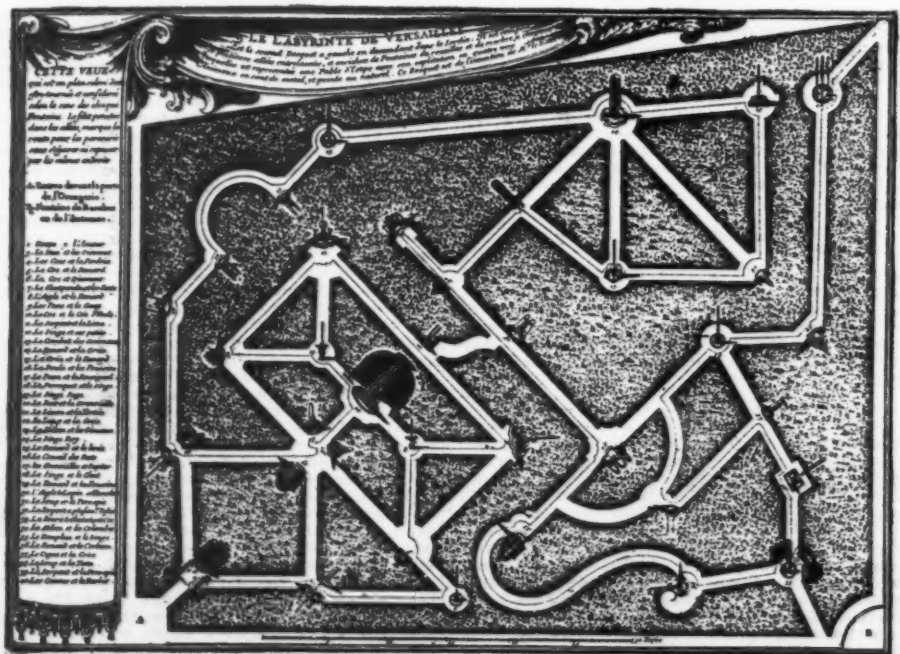


FIG. 5.—PLAN OF THE VERSAILLES LABYRINTH.

posed of yellow or white or blue or black flags; that it was inscribed in a square (Fig. 2), and that its path presented a simple continuous quilloche, but at right angles.

There were 40 of these flags to the side, and if we suppose a width of 16 in. each to the square, the side of the labyrinth must have measured 50 feet, its area have been 3,225 square feet, and the length of the route to be traversed (going and coming) must have been 3,380 feet.

Fig. 3 represents the labyrinth of Saint Quentin. It is of octagonal form, and much resembles those of Amiens and Arras. This latter was destroyed in 1792. The others were destroyed in 1825.

They were in the naves of the churches, and the

It is to be regretted that all this has been in part destroyed, what remains of it at present being merely a small grove containing several paths that continue therein in nearly regular lines, so that it is impossible to go astray. The sparse statues that it contains are far from possessing the attraction that the collection of the most beautiful subjects of *Æsop* must have presented, as Sebastian Leclerc so well says in his magnificent work, wherein each of the said subjects is found represented in a superb full page engraving. To see these successive disappearances of remarkable works, it might be thought that we ought no longer to attach any importance to them, and that we have to-day something better to substitute for them. We do not share that opinion, and we should be glad to see these won-



FIG. 6.—A GARDEN LABYRINTH.

children, in playing "See who will get through quickest," disturbed the religious offices and made it necessary to abolish the labyrinths. It seems to us that it would have been better to abolish the children from the church.

The labyrinth of Bayeux (Fig. 4) is of small size—12½ feet in diameter. It is circular and formed of glazed flags. The path is formed of flags of a dark ground inlaid with yellow ornaments consisting of griffons, arms, etc., which make of it a very curious type of this sort of rarities.

One of the most remarkable was also that of the cathedral of Reims, which was constructed about the year 1240 and was destroyed in 1779.

We now come to garden labyrinths. These are arrangements of narrow, crowded and concentric alleys, whose circulations are formed of groups of plants between which there are entrances that involve a person in long, circuitous paths that often lead him far from the exit of the labyrinth.

Among this kind, employed in the decoration of parks, we may mention the labyrinth of the Garden of Plants of Paris and that of the ancient chateau of Choisy-le-Roi, but we shall dwell more especially upon that of Versailles, which was laid out by Le Notre, and which was ornamented with fountains whose subjects were taken from *Æsop's* fables.

Sebastian Leclerc, in the preface to the book that he has devoted to it, pictures it thus:

"Among all the groves of the small park of Versailles, the one called the labyrinth is especially recommendable by the novelty of the design and by the number and diversity of its fountains. It is called a labyrinth because in it there is an infinite number of small alleys so intermixed with each other that it is almost impossible not to go astray in them. But also, in order that those who get lost in them may get lost agreeably, there is no turn that does not exhibit several fountains at the same time to the sight, so that, at every step, one is surprised by some new object.

"For the subject of these fountains a portion of *Æsop's* fables has been selected, and these are so simply expressed that it would be impossible to see anything more ingeniously executed. The animals, of bronze, colored according to nature, are so well designed that

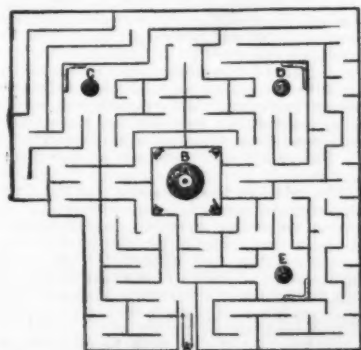


FIG. 7.—PLAN OF GARDEN LABYRINTH.

they seem to be in the very action that they represent, and the more so in that the water that they spurt imitates, after a manner, the language attributed to them in the fable."

If we follow with our eyes the dotted line which in the plan (Fig. 5) shows the route to be taken to traverse the whole and see the thirty-nine fountains that were skillfully disseminated therein, we shall easily discover the shortest road to come out by as soon as one enters; but what seems to us simple upon paper could not have been so in reality, when groups of plants hid the prospect and the concordance of the alleys and their convergence at the final point.

ders revived, at least in our parks and gardens. One amateur has understood this. We shall not name him, as otherwise he would have too many visitors, who would make a public garden of his solitude. On a visit to his garden in order to take a photograph of the labyrinth that ornaments it (Fig. 6), we were delighted to find there one of those original reservations which consists in losing one's self while promenading agreeably in the shade of the foliage, and which gives the visitor the illusion of an excursion in the woods, although the grounds traversed are not over sixty feet square.

Our engraving represents the framework of this labyrinth in winter. The alleys are formed by iron arches, whose two extremities are fixed in the earth, and the continuous coupling of which is arranged in the order shown in Fig. 7. The places that are to form a partition between these iron rods connected by wires and trellises are sowed with the seeds of climbing plants, which, in spring, quickly cover these arbors with verdure, and shut off the view of the roads contiguous to each alley. It is pleasant then to enter this labyrinth through the only door that it contains and to try to reach the center of the promenade, where there is a magnificent fountain. In order to reach it, how many times do we pass over the same route! During the course of such a promenade, we meet with benches, which we can sit upon and regain our patience when we have gone astray. It is one of the most agreeable of recreations, and we recommend it to persons who have at their disposal a small garden in the country. It will not be necessary to copy this type in every respect; each one will modify it according to his fancy and to the place and resources that he has at his disposal.—A. Bergeret, in *La Nature*.

LINCOLN RAM.

The picture shows a Lincoln long-wool sheep—"a fine typical ram," says the *Mark Lane Express*, "belonging to the flock of Mr. Henry Dudding, of Riby



A LINCOLN LONG-WOOL RAM.

Grove, Great Grimsby. These animals have a pedigree extending over 120 years, and their success in the show yards has been almost phenomenal. Three shearing rams from Mr. Dudding's flock which took the first prize at the Royal Agricultural show at Windsor last year were sold for 450 guineas, equal to \$2,250, and were exported to Australia."—*Country Gentleman*.

yet a very ornamental appearance, and even had they not great economic qualities, which the breed certainly possesses, it might have been expected that they would win greater favor than has been the case. But the freaks of popularity are never to be measured by the ordinary rules of life, and we must just take things as we find them in such matters as these. As we have

THE SEVASTOPOL GOOSE.

THE variety of goose which is now under review is called in some cases the Danubian, and it is under that name we generally see it at Continental shows. This is probably the more correct term, for there does not seem any reason to connect it with the town of Sevastopol. Possibly the name may be explained by the fact that it was brought over to this country about the time of the Crimean war by ships returning from the Black Sea, and the name would be given because of the intimate connection of England with Sevastopol



THE SEVASTOPOL GOOSE.

at that time. Less satisfactory reasons than this have been adduced ere this for the giving of an appellation such as this one. It is possible that geese of this description were to be found in the country surrounding the city for so long besieged by the allied troops, but at present there does not appear any evidence that it is at all a resident of Russia. It is common, however, off the banks of the river Danube, and the distance from the mouth of that river to the ports of Southern Russia is not so great as to make the transportation of fowls from the one country to the other a very unlikely thing. It is often by means of ships calling at different ports that varieties of fowls are distributed, and many of the most popular breeds of today have been introduced to notice in this manner. However, the fact that they are common on the banks of the Danube shows that Danubian would be the better name, only when in books and shows we find one term given to a variety it is often better to quietly accept it, for to secure a change, however desirable, is very difficult indeed.

Now the breed has found its way over all western Europe, and there are usually very good classes of Danubians at the French show. At the great show held in Paris recently there were large numbers, and among them some very fine specimens. In Britain it is not very common, in fact not so much so as the qualities of the breed would warrant. The great peculiarity of the Danubian is that the hind-quarters of the bird are covered with loose, shaggy feathers, long enough to trail on the ground. These differ from the frizzled fowls which also come to us from Southeastern Europe, in that they do not curl back in the same manner. The authoress of "Ornamental Waterfowl" describes them by saying that "its peculiarity consists in the extraordinary elongation of the back, wing, and body feathers, which in good specimens trail on the ground, the web being non-adhesive, giving a silky appearance to the birds." This gives them at once a peculiar and

already remarked, they find considerable amount of favor in France, and travelers tell us that very fine specimens are seen in the various countries which lie on the borders of the lower Danube. The scarcity in England makes them more expensive, too, than would otherwise be the case, and this has probably much to do with keeping them in the background. They are not much seen at our shows; only at some of the largest do they make an appearance.

The plumage of the Danubian goose is pure white; in some gray or light brown patches are to be found, but the correct color is pure white. They are moderate layers, but make excellent sitters, and not having the disposition to roam so much as do some other varieties, are on that account to be recommended for all who have only a limited space at their disposal upon which to rear their stock. When used for ornamental purposes they are especially suited to small sheets of water, as they do not take to the wing, and are not so liable to be lost. They are gentle in disposition, and thrive well with other fowls, being also good foragers, and look well after their own living on pastures. They cross freely with other varieties of geese, showing that they are merely a variation from the common goose. The general form resembles that of the Embden, but they have a rosy-red bill, a bright blue eye, and red legs and feet. The weight of the gander is 11 lb., and of the goose about 9 lb., which is less than either the Toulouse or the Embden. For this reason they are more to be recommended as ornamental water fowl than for ordinary purposes, but for private breeders who are not so eager for a very large goose, they combine ornamentation with utility, as the flesh is very good in flavor. The shell is pure white and rough; the period of incubation is from 28 to 30 days.—*Stephen Beale, in Country Gentleman.*

RECENT SYNTHETICAL EXPERIMENTS IN THE SUGAR SERIES.*

PROFESSOR EMIL FISCHER'S researches on the sugars of the glucose group have been remarkably successful, and recently he has effected the synthesis of both dextrose and levulose. A year ago, in the *American Chemical Journal*,¹ the experiments were described by means of which he had succeeded in preparing a new synthetic sugar which he called acrose, and which was found to be an isomer of dextrose and levulose. Acrose possesses all the general properties of dextrose and levulose, and only differs from these natural sugars in being optically inactive. Fischer has now succeeded in determining the constitution of acrose, and in his recent paper;² he has shown that it is the inactive modification of levulose. It bears the same relation to ordinary levulose that racemic acid bears to ordinary tartaric acid; and just as racemic acid can be split into dextro and levo tartaric acids, so from acrose ordinary levulose and a new levulose having an equal but opposite rotatory power can be obtained.

The obstacles that are encountered in this kind of work are very great, and one can gain some idea of the difficulty of determining the constitution of a sugar by remembering that, according to the Le Bel-Van't Hoff hypothesis, a compound with four asymmetric carbon atoms like dextrose can exist in sixteen stereoisomeric forms. Nevertheless, Fischer has not only determined the constitution of sacrose and effected the synthesis of levulose, but he has also discovered the inactive and the levo modifications of mannite and of the new sugar, mannose. He has shown that mannose and dextrose have the same constitution, and that one may be converted into the other. He has further prepared all these substances synthetically, and what is also of very great importance, he has developed and perfected the methods of transforming the sugars and their derivatives into one another to such an extent that the synthesis of the remaining members of the glucose group will probably be effected in the near future. In fact, so great are the additions to our knowledge resulting from these researches, that Fischer's work may well be said to mark the beginning of a new epoch in the history of the carbohydrates.

MANNOSE.

This new sugar was discovered by Fischer in studying the oxidation products of the poly-acid alcohols with the aid of phenylhydrazine. It is obtained, together with levulose, by the oxidation of mannite with nitric acid, and it can readily be distinguished from the other sugars on account of the insolubility of its hydrazone. Mannose has the composition represented by the formula $C_6H_{12}O_6$, and is therefore isomeric with dextrose and levulose, and, like these, it reduces Fehling's solution, and undergoes fermentation when mixed with yeast. It is optically active, and turns the plane of polarized light to the right, but not so strongly as dextrose. Its specific rotatory power is $+12.96$, that of dextrose being $+58.7$. Reduction with sodium amalgam converts it into mannite. Mannose has not yet been obtained in crystalline condition. The white solid sugar deliquesces rapidly in moist air, and is extremely easily soluble in water. It dissolves with difficulty in absolute alcohol, and is insoluble in absolute ether. Like dextrose and levulose, mannose can be converted in furfural and levulinic acid. Treatment with bromine water converts it into mannonic acid, an isomer of gluconic acid.

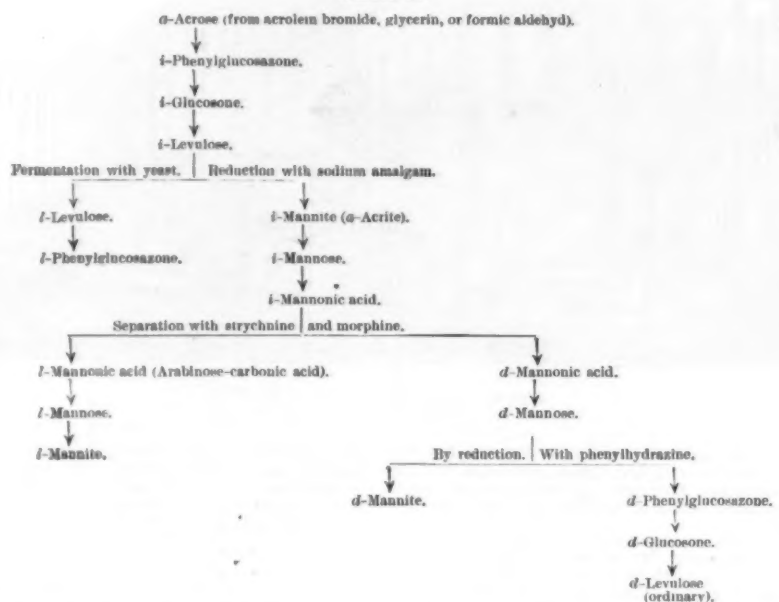
But the distinguishing characteristic of mannose is its behavior with phenylhydrazine. The cold aqueous solution of the sugar, when treated with phenylhydrazine, gives at once a crystalline precipitate of mannose phenylhydrazone, whereas the hydrazones of dextrose and levulose and the other sugars are readily soluble in water. When heated with more phenylhydrazine the mannose hydrazone is converted into an osazone, which is identical in all its properties with phenylglucosazone, the compound that is obtained from dextrose and levulose under similar circumstances. As glucosazone can be converted into levulose, it is therefore possible by this means to transform mannose into levulose.

Constitution of Mannose. ¶—As mannose differs in properties from both dextrose and levulose, it was at

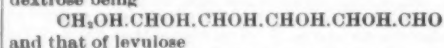
TABLE I.

<i>d-Series.</i>	<i>l-Series.</i>	<i>l-Series.</i>
<i>d</i> -Mannonic acid lactone (dextro-rotatory).	<i>l</i> -Mannonic acid lactone.	<i>l</i> -Arabinose carbonic acid lactone (levo-rotatory).
<i>d</i> -Mannonic acid.	<i>l</i> -Mannonic acid.	<i>l</i> -Arabinose-carbonic acid.
<i>d</i> -Mannose (ordinary) (dextro-rotatory).	<i>l</i> -Mannose.	<i>l</i> -Mannose (levo-rotatory).
<i>d</i> -Mannite (dextro-rotatory).	<i>l</i> -Mannite (<i>a</i> -acritic).	<i>l</i> -Mannite (levo-rotatory).
<i>d</i> -Mannose phenylhydrazone (levo-rotatory).	<i>l</i> -Mannose phenylhydrazone.	<i>l</i> -Mannose hydrazone (dextro-rotatory).
<i>d</i> -Phenyglucosazone (levo-rotatory).	<i>l</i> -Phenyglucosazone (<i>a</i> -acrosazone).	<i>l</i> -Phenyglucosazone (dextro-rotatory).

TABLE II.



first supposed that its constitution was different from that of either of these sugars. Thus, the formula of dextrose being


$$\text{CH}_2\text{OH}.\text{CHOH}.\text{CHOH}.\text{CHOH}.\text{CO}.\text{CH}_2\text{OH}$$

$$\text{CH}_2\text{OH}.\text{CHOH}.\text{CHOH}.\text{CO}.\text{CHOH}.\text{CH}_2\text{OH}$$

suggested itself for mannose. In order to obtain experimental evidence either for or against this formula, mannose was treated with hydrocyanic acid, according to Kiliani's* method of determining the constitution of sugars. Direct addition took place, and from the resulting compound mannose carbonic acid was obtained. This acid, upon reduction with hydriodic acid, was converted into normal heptoleic acid. This result indicates that the constitution of mannose cannot be represented by the formula given above, because a sugar whose constitution is represented by that formula would by this process have been converted into an isohexoleic acid. But the fact that normal heptoleic acid was obtained indicates that mannose contains an aldehyd group, and that its constitution must be expressed by the same formula as that which represents the constitution of dextrose. Mannose and dextrose are, therefore, physical isomers. To explain this isomerism, recourse must be had to the Le Bel-Van't Hoff hypothesis, according to which it is possible to foresee the existence of eight optically active and eight inactive compounds of the formula of dextrose. Both compounds are dextro-rotatory, but as one of them turns the plane of polarized light to a much greater extent than the other, Fischer at first supposed that dextrose and mannose were optical isomers, that they were the dextro and levo modifications of the same structural system, and that the rule which usually holds in such cases, namely, that the one isomer turns as far to the left as the other to the right, was modified in this case in some unknown manner by the remaining asymmetric carbon atoms. This supposition was not confirmed by subsequent experiments, for, as will be shown below, another mannose similar in all its properties to the one here described, but possessing an equal but opposite rotatory power, was obtained from arabinose carbonic acid.

REDUCTION OF THE ACIDS OF THE SUGARS.[†]

Before proceeding to describe how the optical isomer mannose was obtained, it is necessary to call attention to a reaction which is of some importance, and which is a general one for the acids of the sugar series. Ordinarily the carboxyl group of organic acids cannot be reduced to the aldehyde group by means of nascent hydrogen. This reduction, however, takes place readily, as has been discovered by Fischer, in the case of the sugar acids that yield lactones. If gluconic acid lactone, for example, be treated with sodium amalgam, and the solution be acidified from time to time, it soon acquires the power of reducing Fehling's solution, and by continued action a solution of sugar is obtained. The solution contains dextrose, and when it is treated with phenylhydrazine, it gives glucosazone. In the same way mannonic acid, obtained by the oxidation of mannose with bromine water, was reduced with sodium amalgam and mannose again obtained. Other sugar acids behaved in the same way—in short, the method appears to be a general one, and one of very great importance in connection with the synthesis of the sugars.

It is possible by means of this method, together with Kiliani's reaction, to build up a sugar from one containing a smaller number of carbon atoms. For, by treating a sugar with hydrocyanic acid, an addition product is obtained from which an acid containing one carbon atom more than the original sugar can be prepared. This acid can then be reduced with sodium amalgam, and thus converted into the corresponding sugar. The process of lengthening the chain of carbon atoms can then be repeated. Thus far only acids that form lactones have been reduced with sodium amalgam, and it appears that this property is in some way connected with the power of forming lactones.

SYNTHESIS OF MANNOSE AND LEVULOSE.*

When mannose is oxidized with bromine water, it is converted into mannonic acid. A thorough examination of the properties of mannonic acid showed that it has almost identically the same properties as arabinose-carbonic acid. The latter compound was discovered by Kiliani† and is obtained from the addition product which is formed by the union of hydrocyanic acid and arabinose. The lactones of these acids are so similar in properties that they would be regarded as identical were it not for the fact that they rotate the plane of polarized light in opposite directions. As their rotary power is very nearly equal, but in opposite directions, it seemed very probable that they were optical isomers. This supposition proved to be true, for, on mixing solutions of equal weights of the two lactones, an optically inactive compound of the same composition was obtained. This inactive lactone can be transformed into inactive salts and other derivatives, and it is only possible by certain special methods, to be described below, to again resolve it into its optically active constituents. The three lactones can by reduction be converted into sugars, and these in turn into three hexacid alcohols, and the corresponding members of these three series of reduction products bear the same relation to each other as do the original lactones. Thus, from the lactone of mannonic acid mannose and ordinary mannite are obtained, while from the lactone of arabinose-carbonic acid a levo-mannose and a levo-mannite are obtained; and finally, reduction of the inactive lactone gives two corresponding inactive derivatives. The relation of these compounds is shown by Table I.

To avoid confusion the compounds of the three series are designated by prefixing the letters *d*, *l*, and *l* to their names according to the rotatory power of the sugar of the series. The letter *d* or *l* before the name of a compound does not necessarily imply that the compound is either dextro or levo rotatory, but merely that it is a derivative of a dextro or levo rotatory sugar. Thus, the two phenylhydrazine derivatives of *d*-mannose are levo-rotatory.

In a recent paper¹ the preparation and properties of the new sugars *l*-mannose and *l*-mannose and their derivatives are described. Both of them, like *d*-mannose, are stereometric isomers of dextrose. *l*-Mannose can only be fermented with great difficulty, and, like *d*-mannose, it is characterized by the insolubility of its hydrazone. *l*-Phenylglucosazone is the optical isomer of ordinary or *d*-phenylglucosazone, and *l*-mannite of ordinary *d*-mannite.

That *i*-mannonic acid is really the optically inactive modification of *d* and *l*-mannonic acid was shown by splitting it up into its two active components. Two methods were used for this purpose; the first one con-

* *American Chemical Journal*, xli., 257.

† *Ibid.*, xi., 277.

‡ *Ber. d. Chem. Ges.*, xxiii., 872, 876.

§ Van't Hoff, "Dix Années dans l'Histoire d'une Théorie," p. 54.

¹ *Ber. d. Chem. Ges.*, xxi., 1898; xxii., 305.

¶ *Ibid.*, xlii., 365.

* *Ber. d. Chem. Ges.*, xxi., 916.

† *Ibid.*, xxii., 2204.

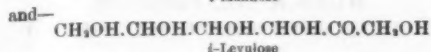
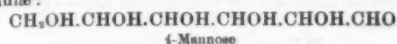
* *Ber. d. Chem. Ges.*, xxiii., 370.

† *Ibid.*, XIX., 3084.

‡ *Ibid.*, xxiii., 373.

sisted in subjecting it to fermentation with *Penicillium glaucum*. The *d*-mannonic acid was consumed by the ferment, while the *l*-acid remained behind and was isolated. The second method depended upon the unequal solubility of the strychnine salts of the two acids in absolute alcohol; the salt of the *d*-mannonic acid being much more soluble than the *l* variety, can be readily separated from the latter. A separation of the optically active constituents of *d*-mannose was brought about by fermentation with yeast. When yeast acts upon *d*-mannose, the *d*-mannose is rapidly consumed and the *l*-mannose remains behind.

Perhaps the most important and interesting discovery made in the course of this admirable investigation was the observation that *d*-mannite and *d*-acrite are identical substances. *d*-Acrite, it will be remembered, is the hexacid alcohol obtained by the reduction of acrose, the new synthetical sugar which had been built up from glycerin, acrolein bromide, and from formic aldehyde. *d*-Acrite has identically the same properties that *d*-mannite has, and, like the latter compound, it can be converted into *d*-mannose. *d*-Acrosazone also is identical with *d*-phenylglucosazone. As, therefore, acrose and *d*-mannose give the same osazone with phenylhydrazine, it follows that the constitution of acrose must be represented by one of the two formulae:

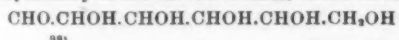


If acrose has the constitution represented by the first one, then it is identical with *d*-mannose, and, like the latter substance, it ought to give a difficultly soluble hydrazone when its solution is treated with phenylhydrazine. Acrose was therefore prepared by direct synthesis from acrolein bromide, and its solution was tested with phenylhydrazine. Under no circumstances could the formation of an insoluble hydrazone be observed. This result, therefore, leads to the conclusion that acrose is *d*-levulose, and its constitution must be represented by the second formula. The synthetical sugar obtained from *d*-acrosazone was also examined in the same way, and, as was to be expected, it also proved to be *d*-levulose.

Further evidence in favor of the view that acrose is *d*-levulose was obtained by observing the changes which it undergoes upon fermentation. When acrose was mixed with yeast it was found that one of the optical components, *d*-levulose, was consumed much more rapidly than the other, and after the fermentation had continued for some time, the *l*-levulose was recognized and separated from the solution by means of its osazone. So also the *d*-acrite, like *d*-mannite, was converted into *d*-mannose and *d*-mannonic acid. But the latter compound can be separated into its optically active constituents, and these in turn can be transformed, on the one hand, into *l*-mannose and *l*-mannite, and on the other hand into ordinary mannose and mannite, and into levulose. Thus the complete synthesis of levulose and of the three series of mannite derivatives has been effected. The successive steps in the synthesis are indicated in Table II.

SYNTHESIS OF DEXTROSE.

As has been shown above, *d*-mannose and dextrose have the same constitution and must be regarded as stereometric isomers. Both sugars give the same osazone when treated with phenylhydrazine. It follows, therefore, that the difference between them is due to the asymmetry of the carbon atom α_1 in the formula:



Fischer also regarded it as highly probable that in mannose the carbon atom α_1 was optically inactive, and that it plays a role similar to that of the two carbon atoms in racemic acid. If this supposition is true, then mannonic acid would be related to gluconic acid in the same way that racemic acid is related to one of the active tartaric acids, or this relationship would be analogous to that of racemic acid to mesotartaric acid. In his last paper† Fischer shows that the latter is the true relation. Each of these acids can be transformed into the other. When either one is heated with quinoline to a temperature of 140°, a mixture of the two acids is obtained. This transformation is analogous to that which has been observed in the case of racemic and mesotartaric acids. When either one of these is heated with water to a temperature of 170° to 180°, a mixture of both is obtained.

For the purpose of preparing dextrose, mannonic acid was heated with quinoline, and from the mixture of acids thus obtained the gluconic acid was separated by means of its brucine salt. The brucine salt was decomposed, and the gluconic acid was found to be identical in properties with the gluconic acid obtained by the oxidation of dextrose. The acid was thereupon reduced with sodium amalgam, and from the liquid anhydrous crystalline dextrose, identical in all its properties with ordinary dextrose, was obtained.

The synthesis of dextrose, therefore, is achieved, for, as will be seen in the table printed above, *d*-mannonic acid has been prepared from acrose, and acrose has been made from formic aldehyde.

PRODUCTION OF HYDROCHLORIC ACID FROM CHLORIDE OF MAGNESIUM.

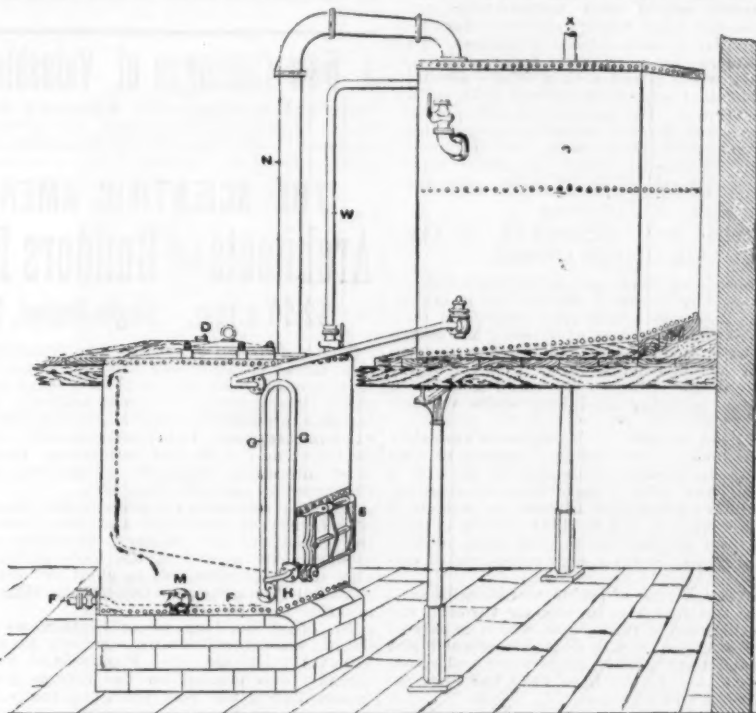
The inventor, F. Kauther, in the *Chemiker Zeitung*, proposes to obtain magnesium and hydrochloric acid by heating to redness a mixture of chloride or oxychloride of magnesium and hydrated chloride of calcium. The last named retains water at a relatively high temperature, at which chloride of magnesium is dissociated and loses all its chlorine as hydrochloric acid, magnesium being left behind. The hydrochloric acid can be condensed in the usual apparatus, and if the fusion is so regulated as to expel only the water of the chloride of magnesium, the condensed acid may have a strength of 40 per cent of HCl. By lixiviation the magnesium is separated from the residue, and the solution of chloride of calcium thus obtained may be used for the next operation.

If to the mixture of the two earthy chlorides a

salt of manganese is added, on heating chlorine will be evolved, which can be used in the manufacture of bleaching compounds.

IMPROVED EXTRACTOR.

We illustrate below an apparatus which has recently been invented by Mr. Joseph Merz, of Brünn, Moravia, for extracting fats, oils, resins, sulphur, colors, and all substances which can be extracted by such solvents as benzene, carbon bisulphide, or alcohol. The extracting apparatus is so arranged that the solvent acts upon the material at a high temperature, but without any pressure, thus insuring the maximum solvent action without any risk. The lower vessel, M, is provided with a steam coil, F, which insures the heating of the solvent that comes in contact with the material in the repository, L. The substance is introduced through the man hole, D, and, after the operation, is removed at E. The upper vessel, R, is the cooler, and contains at V the store of solvent which circulates through the lower pipe on to the material to be extracted. The liquid once in the repository takes up the oil or fat, and after it reaches a certain height, is siphoned through the pipe, G, down to the vessel, M, where it is heated. The vapor resulting from these passes back again into the repository, and is again liquefied. The circulation is thus automatic, and is only interrupted after a sample taken at the faucet, H, shows that the extraction is completed. By then stopping the cooling water in the worm all the solvent is driven over into the reservoir, V, ready for another extraction. The extracted fat or oil free from solvent is drawn off from the cock, U, and the fat-free material is removed at E. The apparatus is recommended for extracting fat from bones, wool waste, leather waste, fish waste, foot greaves, cracklings, and other fatty residues; also for removing oils from seeds and their cakes, from residues obtained in the manufacture of paraffin and lubricating oils, as well as for recovering the oils from cotton waste and oil rags used on railways, steamships and factories.



MERZ'S UNIVERSAL EXTRACTOR.

The extractor has been in use on the Imperial Royal Southern Railroad at Vienna, and in several oil and paraffin works on the Continent and in America, and should prove of advantage in many industries in this country.—*Industries.*

OLEITE, OR RICINOL-SULPHONATE OF SODA.

By W. A. H. NAYLOR.

In a paper read before the American Pharmaceutical Association last year at San Francisco on "Pharmacy as applied to Preparations of the Skin," Mr. Fred B. Kilmer communicated some interesting facts respecting a substance known as oleite.

Chemically, this substance is essentially ricinol-sulphonate of soda. The following descriptive outline of the method of its production is furnished by Mr. Kilmer: "It is prepared from castor oil by treating with sulphuric acid at a low temperature, when a compound of sulphuric acid and ricinoleic acid is formed. The free sulphuric acid being removed by washing, and any unchanged oil by ether, the resulting sulphoricinoleic acid is then neutralized by sodium hydrate, the finished product being a jelly-like liquid, with a little odor, acid taste, soluble in water, alcohol, chloroform, and essential oils." This description is characterized by brevity and vagueness, while the latter part of it is unfortunately so worded as to invite, if not literally to compel, the deduction of an erroneous inference. In the absence of particular knowledge of the action of sulphuric acid upon certain oils, one would conclude that the product of the reaction between the castor oil and the acid—sulphoricinoleic acid—was not sensibly soluble in water or in ether, while as a matter of fact the reverse is the case.

My present object is simply to supply a working formula for the soda compound, one that I have used and can recommend. Take 1 lb. of castor oil, and add to it gradually, with continuous stirring, 2 oz. by weight of sulphuric acid (B. P.). This part of the process will occupy several hours, and should be timed so as to be finished toward the end of the working day.

In the morning introduce in the same manner 1 oz. by weight of the acid, or a sufficiency. The point of finality is reached when the product remains clear, or, as is generally the case, is only faintly opalescent when diluted with about forty times its volume of distilled water.

It is convenient for me here to interpolate the remark that the application of a suitable amount of heat is favorable to the reaction. The temperature of the mixed oil and acid may be allowed to reach 110° F., and may, without detriment, even rise to 120° F. When chemical combination is complete, the product is at once intimately mixed with 1½ times its weight of distilled water, and allowed to stand until separation into two distinct portions has ensued. The supernatant and oily layer is then removed and neutralized with a 10 per cent. aqueous solution of caustic soda. This soda compound is shaken up with five times its volume of proof spirit and set aside, when any free oil will rise to the surface. The lower and spirituous portion is evaporated on a water bath to a thick jelly, the liquid being kept faintly alkaline by the addition of soda solution if necessary.

The resulting product usually contains a small proportion of sulphate of soda, but the quantity is insufficient to rank as a serious objection in view of the uses to which oleite is likely to be applied. If, however, in any case, it is deemed necessary to eliminate traces of alkaline sulphate, the ricinol-sulphonate of soda must be treated with alcohol, in which the latter is soluble and the former practically insoluble.

The free acid (ricinol-sulphonic acid) may be readily obtained by decomposing the soda compound with hydrochloric acid.

IMPROVEMENTS IN ANALYTICAL PROCESSES.

ASSAY OF GUM ARABIC AND GUM SENEGAL. BY LIEBERMANN. (*Chem. Zeit.*)—1. Gum arabic forms round or angular, colorless, yellowish, or brownish lumps, which strongly refract the light, and look as if

they possessed a crystalline structure. Owing to the disturbed state of trade in the Soudan, much of the gum arabic nowadays imported is partly, or even totally, composed of gum senegal.

2. Gum senegal forms either colorless or yellowish lumps, somewhat whitish on the surface (resembling corroded glass), the interior of which is, however, clear and lustrous. The lumps are generally longish, straight or bent, vermicular or cylindrical. Sometimes they look as if small lumps have deposited round a larger one. They have, to a certain extent, the shape of mulberries. If, therefore, the sample is not in powder or too small lumps, the very appearance will tell the fraud.

3. Both varieties are completely soluble in water; there only remains small particles of wood, which, in samples of gum arabic, are generally reddish, but blackish in the gum senegal. These woody particles are found even in the superior kinds of the gum. Other gums, like cherry gum, are only partly soluble in water. There remains a jelly which only dissolves on prolonged boiling.

4. The watery solution of both gums gives with potash lye and a few drops of solution of copper sulphate bluish precipitates; but with gum arabic the precipitate is more abundant, sticks together, and rises to the surface of the fluid. The precipitates are not dissolved on heating, and do not reduce the copper.

5. Dextrine solution also gives a blue precipitate, but this dissolves completely on warming to a clear dark blue fluid. On prolonged boiling the copper gets completely reduced.

6. Heated for a long time with dilute potash, gum arabic or dextrine turns amber yellow, while gum senegal scarcely colors at all.

7. Mixtures of the two gums behave toward potash and copper sulphate like pure gum senegal, but on boiling with potash alone the mixture turns amber-yellow.

8. Mixtures of gum arabic and dextrine behave toward potash and copper sulphate like pure gum, but on long boiling reduction takes place if at least the amount of dextrine is not too small.

* *Ber. d. Chem. Ges.*, xxiii., 383.

† *Ibid.*, xxiii., 790.

9. To detect small quantities of dextrine the liquid must, after a slight warming, be filtered before boiling.

10. In similar manner the separation must be performed when both kinds of gum are present, as well as dextrine. The cupric precipitate containing both gums is washed with distilled water, dissolved in a little dilute hydrochloric acid, and mixed with a large excess of spirit. After standing for a day, the transparent deposit is dried, then dissolved in hot water, and tested according to 4 and 6.

The assay of gum arabic may also be prepared according to the following scheme:

(A.) The appearance of the sample when not in powder. (See 1 and 2.)

(B.) Try the solubility of powdered sample in warm water. (See 3.) If the sample is but partially soluble, and leaves a jelly-like mass, there is no doubt cherry gum. If practically soluble, the solution is mixed with excess of potash and a little copper sulphate, gently heated and filtered:

(a.) The filtrate is treated for dextrine according to 9.

(b.) Precipitate is treated as described in 10. The deposit will either agglomerate and float, or remain suspended in the fluid. In the first case there is gum arabic, and the original fluid will turn amber-yellow with potash. In the second case, if there is no color got with potash, there is only gum senegal.

It has been said gum senegal is more hygroscopic than gum arabic. To make sure, the author dried both specimens at 105° C., and then exposed them for twenty-four hours to moist air, when gum arabic was found to be even a trifle more hygroscopic than the gum senegal.—*L. de K.*

REAGENT FOR SOME ESSENTIAL OILS. A. IHL. (Chem. Zeit.)—Pyrol acts very characteristically on the incrustating material of wood. The author thought of trying its action on ethereal oils, and obtained the following results: Cinnamon oil: A very weak alcoholic solution of this oil gives with dilute alcoholic solution of pyrol, mixed with hydrochloric acid, first a yellowish-red color, which soon turns dark red, and finally deposits a dark colored substance. This test is a delicate one for both pyrol and the oil. Oil of cloves: This, when mixed with a dilute alcoholic solution of pyrol and some hydrochloric acid, gives a splendid carmine color. The same occurs with pimento oil. Oil of saffron gives a splendid rose-red color. Spearmint oil gives but a faint reddish coloration, and aniseed oil only a yellowish color. The author thinks these oils are closely related to the woody substance.

THE SECRETION OF CARBONATE OF LIME BY ANIMAL ORGANISMS.

In a paper on "Coral Reefs and other Carbonate of Lime Formations," by Messrs. J. Murray and R. Irvine, read before the Royal Society of Edinburgh and published in *Nature* for June 12, the following account is given of some experiments carried out at the Scottish Marine Station for Scientific Research, with the object of throwing light upon the secretion and solution of carbonate of lime by living organisms under varying conditions:

Experiment 1.—A number of laying hens were shut up in a wooden building, all ordinary sources of lime being withheld. In a few days the eggs, in place of a calcareous shell, had only a membranous covering. Thereafter sulphate, phosphate, nitrate, and silicate of lime were successively added to their otherwise limeless food, and from all these salts they were enabled to form normal shells for their eggs consisting of carbonate of lime.

From the investigations of Irvine and Woodhead it is believed that the lime salts in passing through the blood assume the form of phosphate, which is carried to the point of secretion, where it is decomposed and deposited as carbonate. When magnesium and strontium salts were added to the hens' food, the eggs became membranous and shell-less.

Experiment 2.—Artificial sea water was prepared, from which carbonate of lime was rigidly excluded. In this water crabs after ecdysis produced the usual exoskeleton of carbonate of lime from the lime salts, other than carbonate, present in the water.

Experiment 3.—The artificial sea water of experiment 2, which was perfectly neutral before the introduction of living crabs, in the course of a short time became distinctly alkaline in character. This was found to be due to the decomposition of their effete nitrogenous products, and the formation of carbonate of ammonia, and ultimately of carbonate of lime.

Experiments 4 and 5.—Sea water was mixed with urine and kept at a temperature ranging from 80° to 90° F. After a time the whole of the lime present in the sea water was thrown down as carbonate and phosphate.

Experiment 6.—A number of small crabs were placed in two liters of ordinary sea water, and were fed with mussel flesh. This water was not renewed, the effete matters from the crabs passing into it. After a few days the crabs died; the water being then in a putrid condition, was set aside at a temperature of from 70° to 80° F., when it was found that practically the whole calcium in the sea water had been thrown down as carbonate of lime.

Experiment 7.—We obtained absolutely fresh "liquor" from a number of living oysters, and examined it before decomposition had begun. It appeared to be a mixture of lymph with unchanged sea water. The specific gravity was 1.023, indicating a considerable admixture of fresh or river water. This liquor contained 0.1899 gramme per liter of total lime in excess of that present in sea water of the same specific gravity, and its alkalinity was equal to 0.2581 gramme per liter in excess of sea water of the same specific gravity.

Thus we had in this liquor an accumulation of total lime (in excess of that present in sea water) amounting to 0.1899 gramme per liter, the greater part of which was in the form of carbonate in solution, presumably in an amorphous or hydrated condition. Apparently this is due to the direct secretion of carbonate of ammonia by the cells of the living animals, which, reacting on the sulphate of lime in the sea water, is capable of throwing out nine-tenths of the soluble calcium salts present, in the insoluble condition of carbonate. The oyster liquor was found to contain saline ammoniacal

salts in enormous excess over that which is present in ordinary sea water.

Experiment 8.—A similar experiment was made with the liquor taken from living mussels. The results coincided with those obtained in experiment 7.

Theoretically, urea plus two molecules of water will give carbonate of ammonia. If therefore this substance be a stage in the formation of urea, it is not unnatural to suppose that in shell-forming animals the shell formation may take place at this stage without the formation of urea at all. In these experiments the usual method for the estimation of saline and albuminoid ammonia could not be followed, and we made use of the following simple adaptation, by which we obtained concordant results.

Absolutely pure potash was added to a measured and carefully filtered portion of the sea water under examination, and the precipitate formed removed by filtration. The clear filtrate was then neutralized in the usual manner. We had thus an accurate means of determining between the actual ammoniacal salts and the albuminoid matter, both of which are, as a rule, present in sea water according to the amount it carries of living and dead organisms. To satisfy ourselves that the addition of pure potash to a fluid containing albuminoids alone does not give rise (immediately) to the production of saline ammonia, we treated pure albumen taken from a newly laid egg in this manner, as also urea, without obtaining any trace of ammoniacal reaction.

AGREEABLY to the wish of the late James Lick, founder of the Lick Observatory, Mt. Hamilton, Cal., for which he gave \$700,000, his remains were entombed beneath the foundation of the great telescope in that institution. It has been decided by the trustees to remove the iron pillar which supports the telescope and substitute a pier of solid masonry, and also to remove the remains of Mr. Lick and bury them in the grounds of the State University. A protest has been entered by the Society of California Pioneers against this desecration.

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